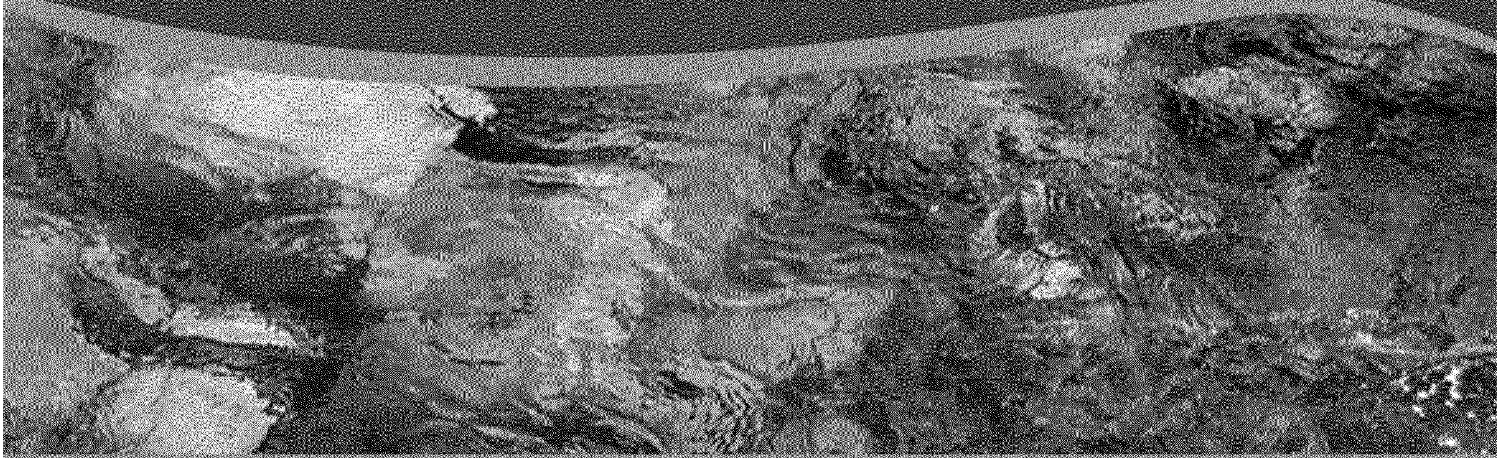
STATEMENT OF QUALIFICATIONS

ANCHOR QEA



# OVERVIEW OF ANCHOR QEA – STATEMENT OF QUALIFICATIONS

**Prepared for**

Lower Passaic River Cooperating Parties Group

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## OVERVIEW OF ANCHOR QEA

Anchor QEA, LLC (Anchor QEA), is a nationally recognized environmental and engineering consulting firm that specializes in aquatic, shoreline, and water resource projects. With offices nationwide, Anchor QEA has extensive experience and expertise in water resources, surface water and groundwater quality, coastal development, habitat restoration, and contaminated sediment management. Anchor QEA provides clients with a full range of science and engineering services, including planning, scientific investigation, engineering design, and construction management. The company works with both public and private sector clients on some of the most challenging sites in the nation, and our completed projects are among the most successful in the industry. The strength Anchor QEA brings to each and every project reflects our core values of technological leadership, integrity, superior product quality, and client satisfaction.

Our staff, which include a mix of sediment scientists; chemists; toxicologists; risk assessors; fisheries biologists; civil, geotechnical, environmental, and coastal engineers; and construction specialists, have designed a wide range of cleanup solutions in a variety of aquatic environments (including marine, estuarine, and freshwater). We apply our understanding of the front-end of site investigations and future site restoration and development plans to evaluate how cleanup measures will fit with the nature and extent of contamination and restoration needs. As a result, we develop cost-effective, feasible solutions that effectively meet our clients' needs. Anchor QEA has a wide range of competencies within contaminated sediments, including the following assessment, engineering, design, habitat restoration, and construction tasks:

- Aquatic risk assessments
- Source evaluations
- Remedial investigations (RI)
- Habitat evaluations
- Feasibility studies (FS)
- Natural Resource Damage Assessments
- Habitat creation/restoration assessment, design, and implementation
- Constructi on/bid documents
- Geotechnical engineering
- Coastal engineering
- Constructability review
- Dredging and disposal planning
- Cap erosion analysis and design
- Equipment selection and evaluation
- Confined disposal facility design
- Sediment dewatering and upland transfer analysis
- Construction cost estimating
- Bid evaluation/contractor selection
- Construction management
- Compliance monitoring

Anchor QEA provides these services during all phases of project development and implementation—from initial planning through construction support—and has worked for private industries, public agencies and utilities, port authorities, architectural and engineering firms, and law firms. This qualification package describes our firm's experience in the numerical modeling of contaminated sediment sites, which is often an integral component to several of the service areas listed above.

# MODELING CAPABILITIES

Anchor QEA's top-quality modeling capabilities are a result of the firm's personnel and technology. Several Anchor QEA staff members are nationally-recognized experts in the field of modeling (e.g., sediment transport, contaminant fate and transport, and contaminant bioaccumulation). Anchor QEA also maintains a network of high performance computer hardware, and the firm has expertise in the most up-to-date surface water and groundwater models that are used to simulate a contaminant dynamics at a site. In fact, Anchor QEA personnel have developed the code for some of these models. Our diverse modeling experience allows us to select and apply the appropriate tools that are needed to address each site's unique characteristics and specific questions to be answered regarding remedial strategy. Thus, our modeling studies can range from relatively simple calculations to complex numerical frameworks that represent a large-scale system. We work with our clients to develop a modeling approach that is technically defensible and provides the necessary decision making information within a project's budgetary and schedule constraints.

## Hydrodynamics

The quantification of hydrodynamic processes is critical to understanding sediment transport and other transport processes. Anchor QEA applies computer simulations to predict velocities, tidal elevation (water depth) and mixing rates for time periods ranging from individual storm events to decade-long continuous simulations. Hydrodynamic models provide the foundation for solving problems, such as solids transport and sediment erosion in estuaries, bays, and coastal waters as well as the fate of outfall discharges and contaminants in these aquatic systems.

Anchor QEA has developed and applied a variety of hydrodynamic and hydrologic models to a wide range of waterbodies and water quality issues. The rigor applied by Anchor QEA to the understanding of a system's hydrodynamics and hydrology depends upon the nature of the problem, the time and space scales of importance, and the level of accuracy required. In some instances, simple water routing is sufficient to meet project needs without consideration of the physics of water movement. Other problems may require one-, two-, or three-dimensional representation of the hydrodynamics of water movement.

### *Hydrodynamic Modeling*

State-of-the-science, three-dimensional hydrodynamic models used by Anchor QEA can predict the current velocity, water surface elevation, and mass transport requirements for many water quality simulations. Anchor QEA's hydrodynamic model applications have addressed flow in rivers, lakes, estuaries, bays, and coastal waters, providing the foundation for the modeling of sediment transport, plume dynamics, chemical fate, and eutrophication. Anchor QEA's coastal engineering applications focus on the effects of tides, residual currents, stratified flow, storm surges, and other coastal hydrodynamic processes on shoreline stability, sediment transport, and structural designs.

Mixing zone analyses are performed to assess when and where a plume reaches far-field conditions as well as the effluent concentration as the plume migrates. Entrainment of ambient water surrounding the plume is a key process that must be evaluated in a mixing zone analysis. Anchor QEA has expertise in both simple and complex plume models. Reliable hydrodynamic modeling of an aquatic system requires both data analysis and model development as well as application expertise. Anchor QEA has extensive experience in analyzing and integrating hydrodynamic data collected in rivers, lakes, reservoirs, estuaries, and coastal ocean zones. Data are used to develop a detailed understanding of the primary hydrodynamic processes and inform the selection and application of a computer model. For example, a three- dimensional hydrodynamic model is often needed to accurately simulate density-driven circulation in an estuary, whereas a one-dimensional model may be entirely adequate for a small river.

Anchor QEA possesses experience with a suite of publicly-available hydrodynamic models that can be applied to a range of water quality and coastal engineering problems. Depending on the type of aquatic system and the requirements of the project, Anchor QEA expertly develops and applies one-, two-, or three-dimensional hydrodynamic models. In addition, Anchor QEA has extensive experience in the analysis of plumes, including development and application of near-field mixing zone models.

Effective presentation and communication are key components of any hydrodynamic or hydrologic modeling application. Hydrodynamics often form the basis for water quality and sediment transport assessments. Consequently, model results require quick, efficient, and comprehensive evaluation during model development. High-quality graphical presentations of model results are used to aid in the interpretation of hydrodynamic processes, particularly in estuarine and coastal regions. Our personnel possess exceptional skills in preparing graphical presentations of hydrodynamics and hydrologic data and modeling results using GIS as well as higher-order programming environments. Animations of model results are used to support model development and to clearly communicate results to clients and stakeholders.

## Contaminant Fate and Transport Modeling and Assessment

Anchor QEA is considered one of the premier water quality modeling firms in the country. Contaminant fate and bioaccumulation modeling and analysis is one of our core competencies , and our personnel are nationally-recognized experts in sediment transport, contaminant fate and transport, and bioaccumulation. We possess particularly extensive experience in conducting PCB fate studies in rivers, and Anchor QEA personnel have worked on many high-profile PCB sites, including Hudson River, Grasse River, Housatonic River, New Bedford Harbor, and Lower Fox River/Green Bay. We have pioneered many of the models and analysis techniques in this field. Finally, Anchor QEA personnel are model developers, not simply users of commercial or public domain models. Indeed, we have authored most of the mathematical code comprising the models. Currently, Anchor QEA uses AQFATE, a more advanced chemical fate model that is the result of research conducted over the past 30 years as well as the insights gained from extensive experience in applying models to contaminated sites. AQFATE is a living tool: we update the framework as new research appears, and we add custom capabilities as needs arise during site-specific applications.

This tool is applicable to a wide range of sites, including oceans, estuaries, rivers, and lakes. The model framework includes all of the major physical and chemical processes underlying chemical fate and transport, including advection, dispersion, particle settling, diffusion, bioturbation, and burial within the sediment bed, resuspension, volatilization, partitioning, and transformation. Both water column and sediment dynamics are simulated in the AQFATE framework. The model is seamlessly linked to hydrodynamic and sediment transport models, providing a complete modeling tool for evaluating contaminant sources as well as potential remediation actions. We have also linked this model with a watershed model to provide increased reliability of key watershed input information (i.e., flows and concentrations of constituents in tributaries). This integrated set of models provides a quantitative tool for the evaluation of a diverse array of problems, including the development of total maximum daily loads (TMDLs) for sediments and contaminants.

The model can be applied to a wide range of compounds, including hydrophobic organic compounds, mercury, and other metals. We have applied the model framework as a screening tool to aid in providing a first-order understanding of chemical fate and transport at data-poor sites and designing data collection programs. We have also performed intensive applications of the model at complex, data-rich sites, which require the greatest accuracy and reliability possible for remediation decision-making, by integrating the results of years of field and laboratory research.

### *Water Quality and Contaminant Transport*

Anchor QEA provides water quality services for freshwater, estuarine, and marine systems in a variety of regulatory frameworks. This includes expertise with water quality issues in a variety of areas from relatively pristine or undeveloped watersheds to developed areas and industrial discharges. Results of these studies are often used to evaluate the relative success or failure of contaminant cleanup or containment efforts. Our expertise in managing and staffing these water quality programs ensures that monitoring and reporting requirements and regulatory concerns are met.

Many of Anchor QEA's aquatic-based projects are associated with upland contaminant source areas. The conceptual exposure pathway model for most sites includes groundwater transport to surface water. Anchor QEA hydrogeologists characterize the fate and transport of chemicals as they are encountered at a wide range of industrial settings ranging from wood products manufacturing to microelectronics, petroleum refining, and other industries.

## Sediment Transport Modeling

Anchor QEA is nationally recognized for assessment and modeling of sediment transport and the evaluation of sediment stability in both riverine and coastal environments. Sediment transport processes, particularly during storm conditions, control the transport and fate of particle-reactive chemicals. Moreover, suspended sediments often pose a water quality concern themselves; thousands of water quality impairments around the country focus specifically on excess sediment loads. Finally, coastal engineering problems often center on sediment transport issues, including sedimentation in navigational channels, sand transport in the littoral (near shore) zone, sediment resuspension during dredging or cable trenching, and scour around sea-bed structures, such as pipelines.

Sediment transport studies conducted by Anchor QEA use a combination of data and modeling analyses to evaluate suspended and bed load transport of cohesive (muddy) and non-cohesive (sandy) sediment. We design and execute field and laboratory studies aimed at collecting site-specific sediment transport data, and conduct experiments to better understand resuspension and deposition processes.

Various levels of sophistication are applied to assessing sediment transport. Studies range from a screening-level analysis to a complex modeling study; the appropriate level of analysis depends upon data availability, required level of accuracy, and schedule and resource constraints. With experience in over 40 systems—from small streams to the open ocean—Anchor QEA personnel have continued to advance the development of state-of-the-science, two- and three-dimensional numerical models of cohesive and non-cohesive sediment transport for application in rivers, lakes, estuarine, and coastal waters.

### *Coastal Engineering Applications*

Coastal engineering studies in the near shore zone encompass a variety of analyses that are used to evaluate the morphodynamics of beaches and shorelines. Often, these analyses are performed to evaluate the impacts of beach nourishment; structures, beach, and shore modification; and natural processes (i.e., a rare storm) on geomorphology and sediment transport along the shore. Our experience and expertise in sediment transport, as well as hydrodynamics and wave propagation, allows us to efficiently address beach and shoreline problems. A combination of data analysis and modeling is applied to examine various cross-shore phenomena that contribute to beach morphodynamics and surf zone dynamics. In the long shore direction, shoreline evolution is assessed by examining short- and long-term erosion and accretion processes. By appropriately combining cross-shore and long shore analyses, Anchor QEA assesses a wide range of near shore problems, including beach erosion, effectiveness of shore protection, and the impact of sand bypassing.

## Eutrophication Analysis and Modeling

Anchor QEA has extensive experience in evaluating water quality data and developing, calibrating, and applying both off-the-shelf and custom eutrophication models. In support of nutrient analyses, Anchor QEA personnel have developed and published a state-of-the-science eutrophication model containing advanced algorithms to describe organic matter cycling caused by bacteria and zooplankton dynamics. For the Seneca River in New York, Anchor QEA created an integrated two-dimensional, time-variable hydrodynamic, water quality, sediment flux, and zebra mussel model to describe nutrients, phytoplankton, and dissolved oxygen. This model is being applied to assess the feasibility of diverting 85 million gallons of effluent per day from the eutrophic Onondaga Lake, New York, to the adjacent Seneca River. This model was subject to a rigorous peer review process. The independent panel of national experts favorably reviewed the modeling effort and formally recognized Anchor QEA's capabilities when it wrote:

> "The Anchor QEA staff is highly qualified in that they have much experience in developing and testing water quality models in a variety of environmental settings."

Anchor QEA's sediment flux model code, developed as part of the Seneca River model, was also favorably reviewed by the U.S. Environmental Protection Agency (USEPA) and is currently being incorporated into the USEPA's flagship eutrophication model referred to as the Water Quality Analysis Simulation Program (WASP).

Anchor QEA's experience ranges from developing nutrient TMDLs following a tight schedule and budget to creating custom applications for larger, more complex systems. We have a broad range of experience modeling nutrients, from oligo-mesotrophic Lake Travis in Central Texas to hypereutrophic Onondaga Lake in Central New York, and are well versed in the most common modeling frameworks, including QUAL2E, WASP, and CE-QUAL-W2.

## Groundwater Investigation and Modeling

Many of Anchor QEA's aquatic-based projects are associated with upland contaminant source areas. The conceptual exposure pathway model for most sites includes groundwater transport to surface water. Anchor QEA hydrogeologists characterize the fate and transport of chemicals at a wide range of industrial settings. Our experience includes projects ranging from wood products manufacturing to microelectronics, petroleum refining, and other industries.

Anchor QEA scientists and engineers have also been involved with several urban Brownfield redevelopment projects. On these assignments, we developed soil and groundwater management plans that provide the protocol for risk-based cleanup and redevelopment. Highlights of our services include:

- Installation of groundwater monitoring systems
- Water quality sampling and aquifer testing
- Hydrology monitoring
- Contaminant fate and transport modeling; determining rate and extent of contamination
- Design, installation, operation, and maintenance of groundwater containment and treatment systems

Anchor QEA provides groundwater modeling services to assist our clients with developing technically sound and cost-effective remedial strategies at upland, riverine, and coastal sites in a variety of environments. For upland sites, Anchor QEA applies models of groundwater flow and contaminant fate and transport to evaluate remedial alternatives at sites and to assist with the design of remediation systems. We have also used groundwater models to evaluate existing remediation systems for the purposes of refining and optimizing system operation. For example, we have conducted simulation of monthly fluctuations in the groundwater capture zone associated with an extraction well system and modeled the contaminant removal associated with vertical groundwater circulation wells. In addition, Anchor QEA's extensive experience in both surface water and groundwater systems provides us with unique capabilities in assessing and modeling groundwater and surface water interactions. Many of the sites where we have performed modeling studies have included some type of groundwater and surface water interaction, and consequently we have developed various approaches to modeling the transfer of contaminants between groundwater and surface water. For example, we are currently conducting a project on behalf of a major industrial client that involves the development of a modeling framework to simulate flow and associated contaminant transport from upland source areas to adjacent surface water bodies in a coastal setting. Important processes simulated include three-dimensional, density-dependent groundwater flow; tidal pumping; chemical reactions within the groundwater-surface water interface; and flux of contaminants through the sediment bed and into the surface water.

# REPRESENTATIVE PROJECT EXPERIENCE

## Lower Duwamish Waterway Sediment Transport Study, Lower Duwamish Waterway Group, Elliott Bay, Seattle, Washington

The sediment bed of the Lower Duwamish Waterway (LDW), a salt-wedge estuary that flows into Elliott Bay near Seattle, Washington, is contaminated with various chemicals, including PCBs. A critical component of the RI/FS study for the site was developing an understanding of sediment transport processes in the LDW, with a focus on bed stability during high-flow events and the natural attenuation rate of surface-layer sediment.

*Project Highlights:*

- Major contaminated site
- Density driven estuarine circulation simulated
- Sediment stability and contaminant mobilization under high flow events

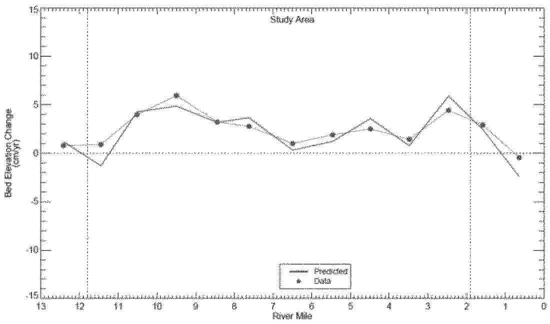
To develop insights about sediment stability and support the analysis of various remedial alternatives, a modeling study was conducted to evaluate sediment transport processes in the LDW during high-flow events and over multi-year periods. The modeling framework for this study consisted of hydrodynamic and sediment transport models that are linked together. The hydrodynamic model was used to simulate estuarine circulation in the LDW. The water depth, current velocity, and bed shear stress information was transferred to the sediment transport model. The hydrodynamic model applied in the study was an enhanced version of the Environmental Fluid Dynamics Code (EFDC). A boundary-fitted curvilinear numerical grid was developed with approximately 1,000 cells in the horizontal plane and 10 layers in the vertical direction. The hydrodynamic model was calibrated using water surface elevation, current velocity, and salinity data collected in the LDW during low- and moderate-flow conditions from August to November 1996 and a high-flow event in January to February 2004.

A sophisticated sediment transport model (SEDZLJ) was used to simulate suspended sediment concentration, deposition and erosion fluxes, and bed elevation changes in the LDW. The model was calibrated and validated over a 21-year period using net sedimentation rate data within the navigation channel and bench areas of the LDW. Successful calibration and validation produced a model that can be used as a reliable management tool to evaluate the efficacy of various remedial alternatives in the LDW. The calibrated model was used to simulate the transport and fate of sediment from different sources (e.g., original bed, external sediment loads from upstream and lateral discharges) over a 30-year period. The results of this simulation are useful for estimating the rate of natural attenuation in the mixing-zone layer of the sediment bed. A spatial-scale analysis was conducted to evaluate model accuracy over a wide range of spatial scales (i.e., 1 to 300 acres). In addition, a comprehensive uncertainty analysis was conducted to identify model inputs that significantly affect model predictions and quantify the effects of uncertainty in the values of those model inputs.

The sediment modeling study has provided important insights about sediment transport processes in the LDW. In addition, the modeling study provided information to support FS analyses and informed remedial decision-making.

**Lower Willamette River Sediment Transport Study, Lower Willamette Group, Portland, Oregon**

The sediment bed of the Lower Willamette River (LWR), a tidal river that flows into the Columbia River near Portland, Oregon, contains elevated levels of various chemicals associated with past industrial practices in the area. A critical component of the RI/FS study for the site was developing an understanding of sediment transport processes in the LWR, with a focus on bed stability during high-flow events and the natural attenuation rate of the surface-layer sediment.




To develop insights about sediment stability and support the analysis of various remedial alternatives, a modeling study was conducted to evaluate sediment transport processes in the LWR during high-flow events and over multi-year periods. The modeling framework for this study consisted of hydrodynamic and sediment transport models that are linked together. The information of the hydrodynamic model that was developed by other firms, such as water depth, current velocity, and bed shear stress, was transferred to the sediment transport model.

The SEDZLJ was used to simulate suspended sediment concentration, deposition and erosion fluxes, and bed elevation change in the LWR. The model was calibrated and validated over a period of 5.5 years using high resolution data on bed elevation changes developed from multi-beam bathymetic surveys within the study area. A spatial-scale analysis was conducted to evaluate model accuracy over a wide range of spatial scales (i.e., 1 to 1,800 acres). Successful calibration and validation produced a model that can be used as a reliable management tool to evaluate the efficacy of various remedial alternatives in the LWR. The calibrated model was used to simulate the transport and fate of sediment from different sources (e.g., original bed and external sediment loads from upstream) over a 7-year period. The results of this simulation are useful for estimating the rate of natural attenuation in the mixing-zone layer of the sediment bed. In addition, a comprehensive uncertainty analysis was conducted to identify model inputs that significantly affect model predictions and quantify the effects of uncertainty in the values of those model inputs. Information from the sediment transport model (i.e., suspended sediment concentrations, deposition and resuspension fluxes) was transferred to a linked contaminant fate and transport model, which was also developed by Anchor QEA for simulating the fate and transport processes of organic contaminants (PCBs, polycyclic aromatic hydrocarbons (PAHs), and organochlorine pesticides) and metals in the study area.

The sediment modeling study has provided important insights about sediment transport processes in the LWR. In addition, the modeling study provided information to support FS analyses and informed remedial decision-making.

## Patrick Bayou Sediment Transport Modeling, Patrick Bayou Joint Defense Group, Houston Ship Channel, Texas

Patrick Bayou is a tidal bayou that flows into the Houston Ship Channel (HSC) in Texas. To develop insights about sediment stability and effects of sediment transport processes on natural attenuation in this bayou, Anchor QEA conducted a modeling study to evaluate its short- and long-term sediment transport processes.

The modeling framework for this study consisted of three models that were linked together:

1. Watershed
2. Hydrodynamics
3. Sediment transport

The watershed model was used to provide freshwater inflow to Patrick Bayou due to runoff from surrounding watershed during rainstorms. This information was used as input to the hydrodynamic model.

A three-dimensional hydrodynamic model was used to simulated estuarine circulation in Patrick Bayou and the HSC. The model that was applied in the study was an enhanced version of the EFDC. A boundary-fitted curvilinear numerical grid was developed with approximately 900 cells in the horizontal plane and 10 layers in the vertical direction. The model was calibrated using water surface elevation and current velocity data collected in the bayou during high-flow events in October 2006.

The SEDZLJ model was used to simulate suspended sediment concentration, deposition and erosion fluxes, and bed elevation change in Patrick Bayou. The model can also be used to track the transport and fate of sediment from different sources (e.g., original bed and external sediment loads), which is useful for estimating the rate of natural attenuation in the mixing-zone layer of the sediment bed. The model was first calibrated using suspended sediment concentration data collected during several high-flow events that occurred in October 2006. Then, net sedimentation rate data from the bayou were used to calibrate the model over multi-year periods. The model was validated using empirical estimates of the rate of attenuation of chemical concentrations in the mixing zone. Successful calibration and validation produced a model that can be used as a reliable management tool to evaluate the efficacy of various remedial alternatives in Patrick Bayou.

The modeling study has provided important insights about the sediment transport processes in Patrick Bayou. In addition, model results will be a critical component in evaluating the effectiveness of different remedial alternatives during the FS.

**Housatonic River PCB Assessment, General Electric Company, Pittsfield, Massachusetts**

*Project Highlights:*

- RCRA Site Investigation
- PCB Fate and Transport
- Conceptual Site Model Development

Operations at a former transformer manufacturing facility in Pittsfield, Massachusetts, which is owned by GE, resulted in the release of PCBs to the Housatonic River. Following several years of investigations, a Consent Decree (CD) was issued for the site in 2000 detailing the terms of an agreement reached between GE, the USEPA, and other government agencies regarding cleanup of the Housatonic River downstream of the GE facility. GE and the USEPA conducted extensive sediment and bank soil remediation projects to address PCB contamination within the first 2 miles of the River downstream of the GE facility. As part of the CD, GE was required to conduct both a Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) and a Corrective Measures Study (CMS) to evaluate potential remedial alternatives for the remaining 135 miles of river pursuant to a RCRA permit reissued to GE by USEPA.

The purpose of the RFI was to delineate the nature and extent of PCBs in the Housatonic River downstream of the GE facility, utilizing available data collected since the 1970s. As part of the RFI, Anchor QEA conducted extensive analyses of the site data, which formed the basis for a conceptual site model. A multidisciplinary approach to studying PCBs within the system was used, including: 1) conducting baseline analyses of PCB data for water, sediments, floodplain soils, invertebrates, and fish to discern temporal and spatial trends in PCBs and to gain a quantitative understanding of PCB dynamics; and 2) evaluating several process-specific datasets collected by both GE and the USEPA to develop a better understanding of hydrodynamics, sediment transport, and PCB fate, transport, and bioaccumulation within the system.

The purpose of the CMS was to develop and evaluate remedial alternatives for the portion of the river downstream of the GE facility. This evaluation included ten alternatives for addressing sediments and nine alternatives for addressing floodplain soil (as well as options for treatment and disposition of removed sediment and soil). These alternatives were evaluated under nine criteria specified in the RCRA permit. A key component in the evaluation of the sediment alternatives was the application of a PCB fate, transport, and bioaccumulation model that had been developed by the USEPA for use by GE in the CMS. Anchor QEA applied this model to simulate each of the sediment remediation alternatives. Specifically, model predictions were used to quantify the benefit of sediment remediation under each of the alternatives with respect to reductions in PCB concentrations in water, sediment, and fish, as well as reductions in PCB mass transport to downstream reaches and the floodplain. These model predictions were a key component in the comparative cost-benefit evaluation of the alternatives. Further, model predictions of future sediment and fish PCB concentrations were also compared against a set of potential risk-based cleanup goals as part of the comparative evaluation. A similar set of risk-based cleanup goals existed for floodplain soils; Anchor QEA developed a GIS-based analysis framework to delineate the areal extent and volume of floodplain soil that would need to be removed under each of the floodplain alternatives to meet the associated cleanup goals for human and ecological receptors.

### Grasse River PCBs Data Analysis, Modeling, and Capping Studies, Alcoa, Inc., Massena, New York

The historical discharge of PCBs from an Alcoa, Inc. (Alcoa) production facility in Massena, New York, has contributed to the elevated PCB concentrations observed in resident fish of the lower Grasse River. Although significant reductions of these PCB discharges to the river have occurred at the facility, a fish advisory still exists for the site. A comprehensive remedial program was designed to evaluate the efficacy of several remedial alternatives aimed at reducing PCB levels in the resident fish. As part of this study, Anchor QEA conducted several integrated data analyses and modeling studies directed at developing a conceptual model of PCB fate, transport, and trophic transfer within the system.

Mathematical models were developed to quantify the exposure pathways of PCBs from water and sediment to resident fish in the river. The calibrated models were then used to evaluate the reductions of PCB levels associated with natural attenuation processes and several potential remedial actions including sediment removal and capping. These studies indicated that capping of river sediments is an effective means to reduce PCB levels in fish. Based on these results, Anchor QEA assisted in the design and implementation of the in-river Capping Pilot Study that was conducted in 2001. This effort included the design and implementation of several pre-design studies—including field, laboratory and modeling studies—to evaluate potential cap materials and application techniques for use in the pilot study. More recently, Anchor QEA has developed a numerical model to understand the bottom shear stresses generated underneath ice jams that can potentially affect the physical integrity of an in-place cap. Results of these modeling efforts served as the basis for the design of an armored cap that was placed in the river during the 2005 Remedial Options Pilot Study.

Results of the data and modeling analyses were used to help Alcoa understand PCB fate, transport, and trophic transfer within the lower Grasse River. In addition, the numerical models developed for the site have provided Alcoa with a means to evaluate the efficacy of various remedial alternatives in reducing the human health risks associated with PCB contamination of resident fish.

**Lavaca Bay Mercury Assessment, Alcoa, Inc., Lavaca Bay, Texas**

Mercury releases during the late 1960s from a chlor-alkali facility managed by Alcoa resulted in mercury deposition within the sediments of Lavaca Bay, Texas. The discharges led to high levels of mercury in the fish and shellfish and resulted in a fishing ban within the bay. The Alcoa (Point Comfort)/Lavaca Bay Site was placed on the National Priority List on February 23, 1994, and a RI/FS was developed for the site.

Anchor QEA conducted studies directed at the fate of mercury within Lavaca Bay to aid in the development of the RI/FS. These studies focused on the impacts of storm-induced sediment transport on the erosion and transport of contaminated sediments; the contribution of ongoing mercury sources to bay sediment contamination ; the rate of recovery of bay sediments; and the bioaccumulation of mercury by fish and shellfish. Detailed quantitative models of hydrodynamics, sediment transport, and mercury fate were developed to provide a basis for interpreting data and predicting impacts of storm events. The models were used to predict the degree to which a hurricane might uncover and transport contaminated sediments. In addition, a combination of data analysis and mathematical modeling was used to examine the relative contributions of historical discharges and ongoing sources to mercury contamination in the surface sediments. This work involved mass balance analyses, modeling of mercury accumulation and burial in bay sediments, and modeling of mercury transport from source areas to the bay, with the ultimate goal of determining the efficacy of various remedial options in accelerating the recovery of Lavaca Bay. Modeling and data analysis were also used to investigate the pathways of mercury transport from water and sediment to fish and shellfish of concern, including red and black drum and blue crabs. This work focused on determining the probable response of the biota to reductions in mercury loading to the bay and to remedial actions directed to particular sediments within the bay.

Anchor QEA's efforts in modeling and data analysis for developing the RI/FS aided in the identification of an ongoing source of mercury from the groundwater under the plant site to Lavaca Bay. This discovery was key to implementing a remediation plan that quickly resulted in noticeable changes in mercury levels in the nearby bay sediments. Moreover, simulation of the relatively minor impacts of hurricane forces on sediment mercury redistribution in the bay convinced stakeholders that extensive dredging in the bay was not necessary to control mercury risks at the site.

## Brunswick LCP Feasibility Study, Honeywell, Brunswick, Georgia

This hydrodynamic modeling study was performed to support a FS at the LCP Chemicals, Inc., site in Brunswick, Georgia, and to evaluate the characteristics and system responses to various remedial alternatives. The Brunswick LCP site is located in the upper portions of an estuarine system that is composed of the South Brunswick and Turtle rivers. The study area includes a complex system of tidal creeks that are connected to and interact with relatively large areas of intertidal, vegetated marshes. The primary objectives of the modeling study were to develop a conceptual site model and to evaluate the potential effects of various remedial alternatives on hydrodynamics and circulation within the study area.

The technical approach focused on the development, calibration, and application of a hydrodynamic model of the study area. The RMA-2 hydrodynamic model was used for this study. This model is a component of the Surface Modeling System developed by the U.S. Army Corps of Engineers (2011), and it has been used to simulate hydrodynamics at numerous estuarine sites. The RMA-2 is a two-dimensional, vertically-averaged model that uses an unstructured numerical grid, which makes it possible to represent complex system geometry and bathymetry over a wide range of spatial scales accurately. This capability is useful for incorporating the secondary and tertiary creek channels within the study area into the model. In addition, RMA-2 is able to simulate flooding and drying of intertidal channels and marsh areas.

*Project Highlights:*

- RMA-2 hydrodynamic model
- Estuary flooding and drying
- Evaluation of Remedial Alternatives

The calibrated model was able to reproduce four key characteristics of hydrodynamics within the study area: 1) amplitude and phase of water surface elevation; 2) qualitative differences in asymmetry of tidal currents during ebb and flood tide; 3) changes in magnitude of along-channel velocity; and 4) flooding and drying of secondary channels and intertidal marshes. Successful calibration of the model indicated that it could be used as a management tool to evaluate remedial alternatives for a wide range of flow and tidal conditions.

The model was used to evaluate hydrodynamics and circulation within the study area for typical tidal conditions, 100-year flood, and hurricane storm surge. The potential effects of several remedial alternatives on maximum current velocities and circulation patterns were evaluated and compared to current conditions to guide remedial action.

## Hydrodynamic Modeling Analysis for the Lower Rouge River Old Channel, Honeywell International Inc., Detroit, Michigan

The Lower Rouge River Old Channel (LRROC) is located in Detroit, Michigan. As part of a FS being conducted for the LRROC, a hydrodynamic modeling study was conducted to develop a management tool that can be used to address these three questions: 1) what are the circulation patterns, current velocities, and bed shear stresses in the LRROC for a range of flow conditions in the Detroit and Rouge Rivers; 2) what is the potential for erosion of the sediment bed within the LRROC during high-flow events; and 3) what are the stable grain sizes of capping materials that may be placed in the LRROC as part of a potential remedial action.

*Project Highlights:*

- Hydrodynamic modeling
- Feasibility Study
- Sediment Remediation

The hydrodynamic model that was used in this study was the EFDC. The model domain included the LRROC and portions of the Detroit and Rouge Rivers. A boundary-fitted, curvilinear numerical grid was developed for the study area. A relatively high-resolution numerical grid was used in the LRROC and adjacent Zug Island area, while a relatively coarse resolution grid was used in the Detroit and Rouge Rivers.

The hydrodynamic model was calibrated using current velocity data collected at multiple transects in the LRROC during six surveys in 2011. The calibration results demonstrated that the model was sufficiently accurate for use as a management tool during the LRROC FS. Model results indicated that circulation in the LRROC is primarily controlled by the slope (along-channel gradient) of water surface elevation in the Detroit River. The hydrodynamic model was used to predict the spatial distributions of current velocity and bed shear stress during a 100-year flood in the Detroit River and Superstorm Sandy in 2012. Model predictions indicated that significant bed scour is unlikely to occur during a rare high-flow event.

## Quanta Sediment Stability Study, Honeywell International Inc., Edgewater, New Jersey

The Quanta Resources site is located along the western shore of the lower Hudson River near Edgewater, New Jersey. A sediment stability study was conducted to address the following questions: 1) what is the potential for bed scour within the study area during a high-flow event; 2) in the areas that experience erosion during a high-flow event, what is the potential depth of scour; and 3) what is the potential for re-exposing buried sediment.

Sediment stability at the Quanta site was evaluated through the development and application of hydrodynamic and bed scour models. The three-dimensional hydrodynamic model used in this study is the Stevens Institute of Technology (SIT) version of ECOM, which was developed by Dr. Alan Blumberg who has used SIT-ECOM to develop the New York Harbor Observing and Prediction System (NYHOPS). NYHOPS is capable of realistically and accurately simulating hydrodynamic circulation in the Hudson River estuary. However, the numerical grid resolution used in NYHOPS in the vicinity of the Quanta site was not sufficient to achieve the objectives of the sediment stability study. A near-field model that uses a high-resolution numerical grid was developed to simulate hydrodynamics in the vicinity of the Quanta site. The far-field model (i.e., NYHOPS) provided upstream and downstream boundary conditions for the near-field model. The near-field hydrodynamic model was calibrated using comparisons of predicted and observed current velocities within the Quanta site during October and November 2008.

*Project Highlights:*

- Sediment Stability
- Hydrodynamic Modeling
- Bed Scour Modeling

The bed scour model used in this study was based on SEDZLJ, which has been used by Anchor QEA in numerous contaminated sediment studies. Erosion rate data were collected from the Quanta site during October 2008, and these data were used to specify erosion input parameters for SEDZLJ. The near- and far-field hydrodynamic models were used to simulate 2- and 100-year floods in the Hudson River. The bed scour model predicted the spatial distributions of bed shear stress and potential areas of erosion during these two high-flow events. That model was also used to estimate the potential depths of bed scour in the erosional areas during the 2- and 100-year floods. Relatively shallow bed scour depths were predicted, which is consistent with the physical characteristics of the sediment bed within the Quanta site. The flood simulations were repeated using post-remediation bathymetry, with negligible differences in predicted scour depth due to the modified bathymetry.

## Evaluation of Hydrodynamic and Sediment Transport Processes at the St. Helens Fiberboard Plant, St. Helens, Oregon

This hydrodynamic study was performed to support a RI/FS at the St. Helens Fiberboard Plant in St. Helens, Oregon. The primary goal of this study was to use hydrodynamic, geomorphology, and geochronology analyses to develop the conceptual site model and support the remedial investigation.

Historical aerial photographs between 1929 and 2011 were examined for changes in site morphology. This exercise indicated that large-scale morphological changes (i.e., increased vegetation) occurred within the study area and that the site is historically depositional. Radioisotope cores were collected from the site and used to conduct a geochronology analysis. The geochronology analysis provided estimates of historical net sedimentation rates, empirical evidence of sediment stability, and indicated that deposition has occurred historically within the study area. The aerial photograph and geochronology analyses provided insights to hydrodynamic and sediment transport processes within the site and were used to refine the conceptual site model.

*Project Highlights:*

- EFDC Hydrodynamic Modeling
- Sediment Stability
- Geochronology Analysis

The hydrodynamic model applied in the study was an enhanced version of the Environmental Fluid Dynamics Code (EFDC), which can simulate time-variable flow in rivers, lakes, reservoirs, estuaries, and coastal areas. An important capability of EFDC for this study was the simulation of flooding and drying in intertidal areas over the course of a tidal cycle, as well as in floodplain areas during high-flow events.

Accurate and reliable simulations of hydrodynamics within the site were accomplished through a nested model structure that consisted of a far-field model, which provided boundary condition information for a near-field model. The far-field model used a numerical grid that included the Columbia River (from Bonneville Dam to Longview), Lower Willamette River, and Multnomah Channel. A high-resolution numerical grid was used in the near-field model to represent the geometry and bathymetry of the site, Scappoose Bay, and portions of the Multnomah Channel and Columbia River.

The hydrodynamic models were used to simulate various combinations of 10-year and 100-year flood events on the Columbia River, Lower Willamette River, and the Scappoose Bay tributaries. The near-field model predicted the spatial distribution of current velocity and bed shear stress during to these flood events, which was used to develop inferences about erosion and depositional processes. The near-field model can be used as a management tool to evaluate hydrodynamic and sediment transport processes within the site over a wide range of flow and tidal conditions and inform the overall hydrodynamic conceptual site model.

## KEY STAFF

Our staff of engineers, environmental planners, scientists, landscape architects, and construction managers enjoy every opportunity to apply their technical skills and creativity on a wide range of projects nationwide. Anchor QEA has a strong history of developing effective solutions for our clients' projects, and our staff have gained national recognition for their technical contributions. The following staff members have extensive experience with contaminant fate and transport modeling, and brief biosketches are presented below:

- John P. Connolly, Ph.D., P.E., BCEE, Principal Engineer
- Peter H. Israelsson, Ph.D., Senior Managing Engineer
- Wen Ku, Managing Engineer
- Peter Oates, Ph.D., Senior Engineer
- Ricardo N. Petroni, Senior Managing Engineer

### John P. Connolly, Ph.D., P.E., BCEE, Principal Engineer

Dr. Connolly is a member of the National Academy of Engineering and a nationally recognized expert on contaminated sediments and eutrophication. His work now focuses on surface water and groundwater contamination problems for the purposes of allocation among potential sources, evaluation of remedial options, remedy design, and waste load allocation (TMDLs). He is an expert in water quality modeling and has been involved in the development of several models commonly applied to real-world problems. He is recognized for his ability to communicate complex technical results to the range of stakeholders typically involved in projects and is frequently called upon to make presentations at regulatory hearings, community meetings, and national and regional technical forums. Dr. Connolly has participated in negotiations with regulatory agencies to craft consent decrees governing contaminated sediment sites.

Dr. Connolly is frequently invited to participate in government- and industry-sponsored workshops. He is a member of the USEPA Science Advisory Board. He has worked throughout the United States and in Latin America and Europe. Dr. Connolly has served as an expert witness for industry and government agencies and has provided testimony before the U.S. Congress and the New York State Assembly. He is also a member of the Manhattan College Council of Engineering Affairs.

### Peter H. Israelsson, Ph.D., Senior Managing Engineer

The major focus of Dr. Israelsson's 10 years in environmental consulting has been on contaminated sediment sites, specifically on characterizing sediment and contaminant dynamics via numerical modeling and environmental data analysis in support of conceptual site model development, remedial design, risk assessment, and source identification. Dr. Israelsson is experienced in all phases of numerical model development, and has worked on an array of surface water systems, including riverine, estuarine, and marine settings. Recent efforts include a kinetic sorption based fate and transport model which overcomes the limitations of traditional equilibrium-based models in a computationally tractable manner, and a novel up-scaling approach to parameterizing sub-grid concentration gradients in near-surface sediments. His expertise in fluid mechanics, sediment transport, and contaminant fate allows him to effectively manage investigations of complex systems.

In 2007, Dr. Israelsson rejoined Anchor QEA after conducting PhD research in environmental fluid mechanics at the Massachusetts Institute of Technology. His research was focused on several modeling aspects of the sequestration of carbon dioxide by direct injection to the deep ocean, a proposed climate change mitigation strategy. This research included the development of a novel Lagrangian random-walk modeling technique which allows for the efficient characterizati on of residence times throughout an ocean general circulation model domain, as well as an assessment of the expected acute biological impacts due of several plausible injection schemes. In addition, Dr. Israelsson has conducted graduate work in hydrodynamic and chemical fate modeling of organic pollutants in an urban harbor environment. Beyond his technical training, Dr. Israelsson has a Masters degree in technology policy, with an emphasis on trans-boundary environmental problems and international environmental negotiation.

Prior to his involvement with Anchor QEA, Dr. Israelsson worked on a variety of environmental investigations at Omni Environmental Corporation. Projects included water quality modeling studies, industrial and municipal permitting, treatment technology recommendations, development of GIS databases, and surface and ground water quality monitoring studies. Dr. Israelsson also directed several field studies.

### Wen Ku, Managing Engineer

Mr. Ku is an environmental engineer with more than 14 years of experience in the field. His experience has focused on the analysis of contaminants and their fate and transport in surface water systems, including statistical and graphical analyses of data and the development of mechanistic mathematical models as well as the application of these models to assist evaluation and design or remedial alternatives. Mr. Ku also has extensive experience using GIS and has developed custom GIS applications for the assessment of potential remedial alternatives. Mr. Ku is also proficient in the use of Interactive Data Language for data analyses, data management, and data visualization.

Mr. Ku also has extensive experience in the area of sediment transport. His graduate work focused on the sedimentation pattern at a river-dominated delta.

### Peter Oates, Ph.D., Senior Engineer

Dr. Oates specializes in the development and implementation of mathematical models that describe and predict chemical transport and reaction in surface water and groundwater. At Anchor QEA, he has co-founded advancements in the state-of-the-field theory for mechanisms influencing long-term sediment recovery, including Desorption Kinetics (chemical desorption time-scales are typically longer than particle residence times, implying the commonly applied equilibrium assumption is problematic) and Microscale Theory (numerical grid models typically cannot resolve the true near surface chemical concentration driving the bed/water-column exchange). These theories have been applied to enhance the predictive ability of models Anchor QEA has developed for two CERCLA sites (one a river and the other an estuary).

Dr. Oates has teamed up with Columbia University to study arsenic-laden groundwater in rural South Asia, which the United Nations has called the single worst case of mass poisoning in human history. He is technical lead for developing and calibrating a groundwater and surface water model for Van Phuc, Vietnam. Modeling to date suggests that the younger river water may be the tied to the governing arsenic release mechanisms. He has also developed and implemented groundwater flow and transport models of arsenic in Bangladesh, bioluminescent bacteria, and chromium contaminated colloids. Dr. Oates' doctoral work focused on understanding and modeling how slow mixing in groundwater can control overall chemical reaction rates and how the lack of mixing can cause chemical concentrations in aquifers to be spatially variable. He has conducted field and laboratory research in Haiti, Bangladesh, Waquot Bay, and at Sandia National Laboratories.

Along with code development, Dr. Oates is proficient in using MODFLOW, a U.S. Geological Survey groundwater hydrodynamic model; RT3D, a groundwater fate and transport model; and FEFLOW, an advanced finite element groundwater flow and transport model. He is also well acquainted with statistical methods techniques in environmental sciences.

### Ricardo N. Petroni, Senior Managing Engineer

Mr. Petroni's main expertise is mathematical modeling of hydrodynamic, water quality, and sediment transport processes. He has worked on numerous projects in South America and the United States. As part of a large South American project, he developed a contaminant fate and sediment transport model that was used in several multi-million dollar studies of the Rio de La Plata (Argentina). Associated with that modeling, Mr. Petroni was also involved in the development and deployment of real-time monitoring networks. The hydrologic real-time monitoring system at the Itaipu Dam (Brazil) is one of the examples of his work in this area. In addition to his technical knowledge, Mr. Petroni has developed management skills that led him to become the director of a consulting firm in Argentina and the founder of Fundacion Climagro, a non-governmental organization devoted to the gathering and analysis of climatical information for agro-business in Argentina.

# JOHN P. CONNOLLY, PH.D., P.E., BCEE

**Senior Technical Advisor and Principal Engineer**

## PROFESSIONAL HISTORY

Anchor QEA, LLC, Senior Technical Advisor and Principal Engineer, February 1998 to present
U.S. Environmental Protection Agency (USEPA) Science Advisory Board, 2005 to present
HydroQual, Inc., Principal Engineer, 1993 to January 1998
HydroQual, Inc., Consultant, 1980 to 1993
Manhattan College, Professor, 1992 to 1994
Manhattan College, Associate Professor, 1986 to 1992
Manhattan College, Assistant Professor, 1980 to 1986
USEPA, Environmental Scientist, 1978 to 1980
Manhattan College, Research Engineer, 1975 to 1977

## EDUCATION

The University of Texas at Austin, Ph.D., 1980
Manhattan College, M.E., Environmental Engineering, 1975
Manhattan College, B.E., Civil Engineering, 1973

### *Registration*

Professional Engineer (Inactive), State of Texas (License No. 92122)
Professional Engineer, State of New York (License No. 59428)

## EXPERIENCE SUMMARY

Dr. Connolly is a member of the National Academy of Engineering and a nationally recognized expert on contaminated sediments and eutrophication. His work now focuses on surface water and groundwater contamination problems for the purpose of allocation among potential sources, evaluation of remedial options, remedy design, or waste load allocation (total maximum daily loads [TMDLs]). He is an expert in water quality modeling and has been involved in the development of several models commonly applied to real-world problems. He is recognized for his ability to communicate complex technical results to the range of stakeholders typically involved in projects and is frequently called on to make presentations at regulatory hearings, community meetings, and national and regional technical forums. Dr. Connolly has participated in negotiations with regulatory agencies to craft consent decrees governing contaminated sediment sites.

Dr. Connolly is frequently invited to participate in government- and industry-sponsored workshops. He is a member of the USEPA Science Advisory Board. He has worked throughout the United States and in Latin America and Europe. Dr. Connolly has served as an expert witness for industry and government agencies and has provided testimony before the U.S. Congress and the New York State Assembly. He is also a member of the Manhattan College Council of Engineering Affairs.

## TESTIMONY

### United States of America and the State of Wisconsin vs. NCR Corporation et al.

For defendant NCR Corporation, Dr. Connolly provided expert witness testimony at a preliminary injunction hearing held on April 12, 2012, in United States District Court for the Eastern District of Wisconsin regarding the relative contribution of various paper mills to polychlorinated biphenyls (PCBs) in the sediments of the Fox River.

### State of Oklahoma vs. Tyson Foods, Inc. et al.

For defendants Tyson Foods, Inc. et al., Dr. Connolly provided expert witness testimony at a deposition from April 8 to 9, 2009, and on May 12, 2009, and at a trial on December 18 to 22, 2009, and January 22, 2010, regarding the sources of bacteria and phosphorus in the Illinois River and Lake Tenkiller in Oklahoma, the water quality of these systems, and the impact that poultry litter application in the watershed could have to water quality.

### General Electric Company vs. David E.W. Lines et al.

For General Electric Company, Dr. Connolly provided expert testimony at a deposition on April 23, 2010, regarding the timing of PCB releases and transport in the Upper Hudson River.

### Maine Environmental Protection Board

Dr. Connolly provided expert testimony on May 2, 2007, regarding the deficiencies of a phosphorus, total suspended solids, and biochemical oxygen demand TMDL developed for Gulf Island Pond on the Androscoggin River and the contributions of various sources to existing algal and dissolved oxygen problems.

### Subcommittee on Water Resources and Environment of the U.S. House of Representatives Transportation and Infrastructure Committee Hearing on Strategies to Address Contaminated Sediments

Dr. Connolly provided expert testimony on July 19, 2001, regarding the approaches used by USEPA to address contaminated sediments.

### Maine Peoples' Alliance and Natural Resources Defense Council, Inc. vs. HoltraChem Manufacturing Company, LLC and Mallinckrodt, Inc.

For defendant Mallinckrodt, Inc., Dr. Connolly provided expert witness testimony at a deposition on July 3, 2001, and at a trial on March 12, 2002, regarding mercury bioavailability in the Penobscot River estuary.

### United States of America vs. Montrose Chemical Corporation of California et al.

For plaintiff United States of America, Dr. Connolly provided expert witness testimony at a deposition from July 13 to 17, 1998, and on April, 6, 2000, and at a trial on October 19, 2000, regarding the transfer of dichlorodiphenyltrichloroethane (DDT) and PCBs from contaminated sediment in coastal waters off Los Angeles to fish, birds, and sea lions.

**Kalamazoo River Study Group vs. Rockwell International et al.**

For defendant Eaton Corporation, Dr. Connolly provided fact witness testimony at a deposition on July 22, 1997; expert testimony at a deposition on January 26, 1998; and trial testimony on August 17 and 21, 1998, January 19, 2001, and February 5 and 6, 2001, regarding technical analyses conducted to evaluate the PCB contributions from Eaton's Battle Creek and Marshall facilities to the Kalamazoo River.

**New York State Assembly Standing Committee on Environmental Conservation Public Hearing on PCB Contamination in the Hudson River**

Dr. Connolly provided expert testimony on March 19, 1997, on behalf of General Electric Company regarding the sources of PCBs observed in Hudson River fish.

**Alcoa and Northwest Alloys, Inc. vs. Accident & Casualty Insurance Company et al.**

For plaintiff Alcoa, Dr. Connolly provided expert witness testimony at a deposition on February 28 and March 1, 1996, regarding the nature, extent, and expansion of sediment contamination at Alcoa facilities in Massena, New York, and Point Comfort, Texas.

## REPRESENTATIVE PROJECT EXPERIENCE

### *Contaminated Sediments Assessment and Management*

**Relative Risk and Effectiveness of Remediation in the Lower Passaic River, New Jersey Client: Group of Potentially Responsible Parties known as the Small Parties Group**

Dr. Connolly was the principal investigator for evaluating the relative contributions of the various contaminants of potential concern to perceived risk and the chemical-by-chemical benefits attainable by remediation. Dr. Connolly represented the Small Parties Group in meetings with the larger Cooperating Parties Group (CPG) and led development of a strategy for interpreting site data, crafting a conceptual model, and communicating the strategy and its results to the CPG and USEPA. The objective was to provide a basis to influence the direction of the project feasibility study and to provide an objective basis for cost allocation.

**Peer Review of Contaminated Sediment Remediation Guidance for Hazardous Waste Sites, U.S. Environmental Protection Agency**

Dr. Connolly was one of three national experts tasked with reviewing the draft guidance document that has been developed to provide technical and policy guidance to project managers and management teams making remedy decisions for contaminated sediment sites.

**Source Allocation for Mercury in the Penobscot River Estuary, Mallinckrodt, Inc.**

Dr. Connolly was the principal investigator for evaluation of the relative contributions of sediment and water column mercury to mercury found in resident biota. This study involved data analysis and development of a conceptual model explaining the probable reasons of the apparent lack of impact of elevated sediment mercury concentrations on biota mercury levels. The work was used to provide litigation support through expert testimony. Subsequent to litigation, work has focused on development of a detailed investigation plan, interaction with a court-mandated Study Panel, technical support for the client's legal team, and oversight of planned field work.

### Source Allocation for Mercury in the Peconic River, Brookhaven National Laboratory

Dr. Connolly was the principal investigator for investigations to determine the sources of methyl mercury in the fish of the Peconic River. This study involved the design of sampling programs and interpretation of data to determine the relative contributions of background sources and various sediment deposits throughout the river to methyl mercury in the water and fish. This work was conducted to satisfy a diverse group of stakeholders with differing positions on appropriate remediation. It led to a revision of the contemplated remedial action and a convergence of opinion on the best approach for the river.

### Investigation of Mercury in Lavaca Bay, Alcoa

Dr. Connolly is the principal investigator for the evaluation of mercury sources and prediction of the impacts of remedial actions and storm events on mercury levels in sediment and biota. The project involves data analysis and the development of linked hydrodynamic, sediment transport, mercury fate, and bioaccumulation models. A primary goal is the evaluation of the impact of hurricanes and other rare storms on buried mercury.

### Remediation of the Hudson River PCBs Site, General Electric Company

Dr. Connolly was the principal investigator for various aspects of remedial design (RD), including the design and execution of an extensive pre-design sediment sampling program involving the collection of more than 6,000 sediment cores, management of the RD database, determination of the dredging prisms, design and execution of the baseline and construction monitoring programs, and support of the design of dredging and processing of dredged sediment. This project included the development of sophisticated data entry, data processing, and data display systems that were used by the General Electric Company design team. Additional activities included direct participation in consent decree negotiations.

### Analysis of the Fate of PCBs in the Hudson River, General Electric Company

Dr. Connolly was the principal investigator for extensive data analysis and modeling studies of the dynamics of PCBs in the Hudson River. This study involved field sampling, data analysis, and the development of linked hydrodynamic, physical/chemical, sediment transport, and food chain models for predicting the effects of alternative remediation plans.

### Analysis of the Fate of PCBs in the Grasse River, Alcoa

Dr. Connolly is the principal investigator for the determination of the impacts of contaminated sediments and point sources to PCB contamination in resident fish. Efforts include the design of field sampling programs and estimation of PCB fluxes between water and sediment, including the importance of areas with elevated concentrations and the transport and bioaccumulation in the food web. The goal is to provide a technical basis for examination of remedial options.

**Assessment of Contribution of PCBs to the Kalamazoo River from Eaton Corporation, Eaton Corporation**

Dr. Connolly was the principal investigator for the analysis of data and development of models to evaluate whether either or both of two Eaton facilities contributed measurable quantities of PCBs to the Kalamazoo River. The project involved the compilation and analysis of historical data, design, execution of a sampling program, and development of models to predict the transport of sediment and PCBs through the Kalamazoo River.

**Analysis of the Fate of PCBs in the Housatonic River, General Electric Company**

Dr. Connolly is the technical advisor for extensive data analysis and modeling studies directed to determining the appropriate remedial solution for the contaminated sediments. This study involves data analysis and the development of linked hydrodynamic, sediment transport, PCB fate, and PCB bioaccumulation models. An important aspect of this project is the evaluation of the role of river flooding in PCB fate and impact of floodplain soils.

**Modeling of Heavy Metal and Organic Contaminant Fate in the Pawtuxet River to Support a Resource Conservation and Recovery Act (RCRA) Facility Investigation, Ciba-Geigy Corporation**

Dr. Connolly was the principal investigator for determination of target chemicals by qualitative risk analysis, design of a sampling program, and development of a model to evaluate temporal and spatial concentration reductions resulting from remedial action alternatives including excavation and groundwater treatment.

**Analysis of Dichlorodiphenyl Dichloroethylene (DDE) and PCB Transfer Pathways in the Southern California Bight Ecosystem, National Oceanic and Atmospheric Administration**

Dr. Connolly was the principal investigator for the analysis of data and development of food-chain models to study the relationship between sediment contamination and levels of DDE and PCBs in fish, mammals, and birds. The purpose of this work was to establish probable sources of contamination in support of a Natural Resource Damage Assessment.

***Contaminated Groundwater Assessment and Management***

**Evaluation of Solvent Plume Migration and Fate at the MW Manufacturing Site, Valley Township of Pennsylvania, Lucent Technologies**

Dr. Connolly is the principal investigator for the development and application of flow and transport models to be used to predict the movement and decay of a volatile organic compound plume composed of tetrachloroethene (PCE), trichloroethene (TCE), 1,2-dichloroethene (1,2-DCE), and vinyl chloride. The goal of the project is to estimate whether the plume has achieved a steady-state configuration in response to a nonaqueous phase source and to project discharge rates to a local stream.

**Modeling of Groundwater Remediation Using Vertical Groundwater Circulation Technology, SBP Technologies**

Dr. Connolly was the principal investigator for the development of a strategy to model the treatment efficiency of in situ vertical groundwater circulation technology. Work included the evaluation of circulation, nutrient dynamics, and polycyclic aromatic hydrocarbons biodegradation and volatilization. The goal was to develop a modeling framework that could be used to design sampling strategies and evaluate treatment efficiency.

### *Total Maximum Daily Load Investigations*

**Evaluation of the Phosphorus, Total Suspended Solids, and Biochemical Oxygen Demand TMDL for Gulf Island Pond on the Androscoggin River, Maine, Verso Paper Company**

Dr. Connolly was the principal investigator for the critique of the TMDL developed by Maine Department of Environmental Protection and the examination of the contributions of point and non-point sources to algal and dissolved oxygen problems in the Gulf Island Pond.

**San Francisco Bay PCBs, General Electric Company**

Dr. Connolly was the principal investigator for the review and critique of a draft TMDL document issued by the San Francisco Bay Regional Water Quality Control Board. This study involved the analysis of data and modeling to provide the Board with the information necessary to correct deficiencies in the draft document with regard to natural recovery and the need for, and effectiveness of, available source control options and to develop an effective implementation strategy. The work included the development of presentation materials and a face-to-face meeting with the authors of the document.

**Coosa River PCBs, General Electric Company**

Dr. Connolly was the principal investigator for the review and critique of a draft TMDL document issued by the State of Georgia. This study involved the analysis of data to provide the State with the information necessary to correct deficiencies in the draft document with regard to natural recovery and the need for, and effectiveness of, available source control options and to develop an effective implementation strategy. The work included the development of presentation materials and a face-to-face meeting with the State and with USEPA Region 4.

### *Water Quality/Eutrophication Assessment*

**Assessment of the Environmental Fate and Impact of ICE-B-GON on Lake Wingra, Wisconsin, Chevron Research Company**

Dr. Connolly was the principal investigator for the laboratory determination of the degradation and oxygen utilization kinetics of the de-icing chemical, ICE-B-GON, and projection of the effect of the use of this chemical on the dissolved oxygen of receiving waters, using Lake Wingra as a case study.

**Mathematical Modeling of Water Quality in Lake Erie, U.S. Environmental Protection Agency, Grosse Ile, Michigan**

Dr. Connolly was Project Engineer in charge of data analysis development, calibration of a eutrophication model, which included multiple algal species and zooplankton, and projections of the effects of reduction in point and non-point nutrient loadings on pollution indicators (lake phytoplankton, nutrient, and dissolved oxygen levels).

**Analysis of Heavy Metals, Ammonia, and Cyanide in the Genesee River, Eastman Kodak Corporation**

Dr. Connolly was Project Engineer in charge of data analysis, mathematical model development, and assessment of the relative impact of the Kodak treatment plant effluent on water quality in the Genesee River.

**Analysis of the Fate of Toxic Chemicals in Estuaries, U.S. Environmental Protection Agency, Gulf Breeze, Florida**

Dr. Connolly was Project Manager in charge of development of a mathematical model describing the transport and degradation of toxic chemicals in estuarine environments.

**Development of Version 4.0 of the Water Analysis Simulation Program, U.S. Environmental Research Laboratory, Athens, Georgia**

The purpose of this project was to modify the USEPA water quality model Water Analysis Simulation Program (WASP) (3.2) to provide a single modeling framework for use in all types of surface water problems including conventional and toxic pollutants under steady-state or time-variable conditions. Dr. Connolly's responsibilities included the development of the kinetic routines for the toxic chemical component of the model from those used in EXAMS II, TOXIWASP, and WASTOX; integration of the WASTOX steady-state solution into WASP; and providing technical assistance on all other components of model development.

***Ecological Risk/Natural Resource Damage Assessments***

**Development of Water Quality Criteria for Wildlife, U.S. Environmental Protection Agency**

Dr. Connolly was the principal investigator for the development of methodologies to determine water concentrations protective of aquatic-feeding wildlife. Dr. Connolly defined methods to relate laboratory toxicity estimates to wildlife species. Efforts included compilation and analysis of toxicity data, development of models to permit extrapolation of laboratory toxicity data to field animals, and development of models of the relationship between water column contaminant concentrations and effects in wildlife. Initial work focused on dieldrin and DDT.

**Modeling PCBs in the Aquatic Biota of Green Bay, U.S. Environmental Protection Agency**

Dr. Connolly was the principal investigator for the development and application of a model of PCBs in the food web of Green Bay. This work is part of the Green Bay Mass Balance Study for USEPA. The purpose of these studies was to evaluate the impacts of potential remediation alternatives.

## JOHN P. CONNOLLY, PH.D., P.E., BCEE

**Senior Technical Advisor and Principal Engineer**

**Analysis of PCBs and Metals Contamination in the Biota of New Bedford Harbor, Massachusetts, U.S. Environmental Protection Agency, Region I, Battelle Ocean Sciences**

Dr. Connolly was Project Manager in charge of developing a mathematical model of the contamination of the lobster and winter flounder, and their food chains, in New Bedford Harbor and Buzzards Bay. Dr. Connolly was responsible for linking this model with a hydrodynamic-contaminant fate model developed by Battelle Northwest to project the response of the biota to various remedial action alternatives. This work was part of a USEPA Superfund project in New Bedford Harbor.

**Analysis of PCBs in the Hudson River Striped Bass and its Food Chain, Hudson River Foundation, New York, New York**

Dr. Connolly was Project Manager in charge of the development of a mathematical model describing the accumulation of PCBs in the striped bass food chain.

**Analysis of Kepone Accumulation in the Striped Bass Food Web of the James River Estuary, U.S. Environmental Protection Agency, Gulf Breeze, Florida**

Dr. Connolly was Project Manager in charge of the development and application of a mathematical model describing the accumulation of the pesticide Kepone in the striped bass food chain. Dr. Connolly projected the response of the food chain to declining exposure concentrations.

***Pathogen Fate and Transport***

**Development of a Framework for Predicting the Fate of Genetically Engineered Microorganisms in Surface Water Systems, U.S. Environmental Protection Agency, Environmental Research Laboratory, Gulf Breeze, Florida**

Dr. Connolly was the principal investigator for the development of a model of the population dynamics of bacteria, phytoplankton, and zooplankton in surface waters, and application of this model to predicting the risk associated with the introduction of genetically engineered bacteria to these environments. Population dynamics models were developed for the Delaware River and Mirror Lake.

**Modeling Fate and Transport of Pathogenic Organisms in Mamala Bay, Hawaii, Mamala Bay Study Commission**

Dr. Connolly was the principal investigator for review of historical data, design of a sampling program, and development and calibration of a mathematical model of pathogen fate in Mamala Bay. The goal was to determine the pathogen sources and level of control necessary to meet water quality goals.

**Evaluation of Cryptosporidium Sources and Fate in Milwaukee, Wisconsin, Sara Lee Corporation**

Dr. Connolly was the principal investigator for the evaluation of the likely contribution of various potential sources to the cryptosporidium responsible for a disease outbreak in the City of Milwaukee.

## JOHN P. CONNOLLY, PH.D., P.E., BCEE

**Senior Technical Advisor and Principal Engineer**

### *Hydraulic Engineering*

**Hydraulic Analysis of the Fairfield, New Jersey, Sewer System, Lee Purcell Associates, Inc.**

Dr. Connolly was Project Engineer in charge of determining the capacity and flow characteristics of an in-place sewer system. Dr. Connolly developed a gradually varied flow analysis for this purpose.

### HONORS

National Academy of Engineering, 2010

Honor Member, Chi Epsilon Civil Engineering Honor Society, 2010

Civil, Architectural, and Environmental Engineering Academy of Distinguished Alumni, The University of Texas, 2010

Diplomate Environmental Engineer by Eminence, American Academy of Environmental Engineers, 2002

Manhattan College Environmental Engineering Alumni Club Service Award, 1994

### PROFESSIONAL ACTIVITIES

#### *Affiliations*

National Academy of Engineering

American Academy of Environmental Engineers

Sigma Xi – National Scientific Research Society

Society of Environmental Toxicology and Chemistry (SETAC)

American Society of Limnology and Oceanography

Water Environment Federation

#### *Committees and Advisory Boards*

USEPA Science Advisory Board, Environmental Engineering Committee

1997, USEPA Technical Qualifications Board (to review promotion application)

1991-1996, New York Water Environment Association Outstanding Paper Award Committee

DuPont Technical Advisory Board for Evaluation of Hexamethylphosphoramide (HMPA) Releases at their Spurance Plant in Richmond, Virginia

1990, USEPA Exploratory Research Review Panel

#### *Invited Participation in Technical Workshops*

Addressing Uncertainty and Managing Risk at Contaminated Sediment Sites; St. Louis, Missouri, October 26-28, 2004 – Steering Committee Member

Strategic Environmental Research and Development Program / Environmental Security Technology Certification Program Contaminated Sediments Workshop; Arlington, Virginia, August 10-11, 2004

Stability of Chemicals in Sediments; San Diego, California, April 8-10, 2003 – Steering Committee Member

Sediment Stability Workshop; New Orleans, Louisiana, January 22-24, 2002 – Steering Committee Member

USEPA Forum on Contaminated Sediments; Alexandria, Virginia, May 30 – June 1, 2001

National Research Council Workshop on Bioavailability; Washington, D.C., November 12, 1998

SETAC Pellston Workshop: Re-evaluation of the State of the Science for Water Quality Criteria Development; Fairmont Hot Springs, Montana, June 25-30, 1998

National Academy of Sciences National Symposium on Contaminated Sediments; Washington, D.C., May 27-29, 1998

SETAC Pellston Workshop: Reassessment of Metals Criteria for Aquatic Life Protection; Pensacola, Florida, February 10-14, 1996

California Environmental Protection Agency (EPA) Workshop on Critical Issues in Assessing Ecological Risk; Asilomar, California, January 23-25, 1995

USEPA Workshop on Taura Syndrome; Gulf Breeze, Florida, August 2-3, 1994

USEPA Workshop on Modeling Uncertainty; Buffalo, New York, February 3-5, 1991

USEPA Workshop on Sediment Quality Criteria; Grosse Ile, Michigan, March 29-30, 1990

Industry-sponsored Workshop on the Environmental Impacts of the Deicer Calcium-Magnesium-Acetate; Albany, New York, February 27, 1990

USEPA Workshop on Biotechnology Risk Assessment; Breckenridge, Colorado, January 11-15, 1988

SETAC Workshop on Risk Assessment; Breckenridge, Colorado, August 17-21, 1987

### *Presentations*

PCB Release during Phase 1 Dredging on the Upper Hudson River. 26th International Conference on Soils, Sediments, Water, and Energy, University of Massachusetts, Amherst, Massachusetts, October 19, 2010.

Interpretation of Spatial Patterns of Contaminants in the Lower Passaic River. SETAC 20th Annual Meeting, New Orleans, Louisiana, November 22, 2009.

Long-term Monitoring of PCBs in the Grasse River. Fifth International Conference on Remediation of Contaminated Sediments, Fort Lauderdale, Florida, February 4, 2009.

Overview of the 2005 Grasse River Remedial Options Pilot Study. Fourth International Conference on Remediation of Contaminated Sediments, Savannah, Georgia, January 22-25, 2007.

Challenges to Monitoring and Assessing Natural Recovery. Third International Conference on Remediation of Contaminated Sediments, New Orleans, Louisiana, January 27, 2005.

Monitoring to Support the Dredging Remedy on the Upper Hudson River. Third International Conference on Remediation of Contaminated Sediments, New Orleans, Louisiana, January 26, 2005.

Adaptive Management as a Measured Response to the Uncertainty Problem. Addressing Uncertainty and Managing Risk at Contaminated Sediment Sites, St. Louis, Missouri, October 27, 2004.

Optimal Use of Conceptual and Mathematical Models at Contaminated Sediment Sites. Addressing Uncertainty and Managing Risk at Contaminated Sediment Sites, St. Louis, Missouri, October 27, 2004.

Sampling of Sediment and Water in the Upper Hudson River to Support the USEPA Dredging Remedy. Hudson River Environmental Society Conference, Rensselaer Polytechnic Institute, Troy, New York, October 5, 2004.

Nature and Causes of Non-particle-related Contaminant Releases in Large River Systems. Workshop on Environmental Stability of Chemicals in Sediments, San Diego, California, April 10, 2003.

Management of Contaminated Sediments. National Science Foundation U.S./Italy Workshop on Sediments, Arlington, Virginia, December 10, 2002.

Use of Sound Science to Develop a Defensible Site Model. USEPA Forum on Managing Contaminated Sediments, Alexandria, Virginia, May 31, 2001.

A Quantitative Framework for Evaluating Contaminated Sediment Sites. SETAC 20th Annual Meeting, Philadelphia, Pennsylvania, November 14-18, 1999.

Prediction of Natural Recovery and the Impacts of Active Remediation in the Upper Hudson River. SETAC 20th Annual Meeting, Philadelphia, Pennsylvania, November 14-18, 1999.

Evaluation of Remedial Alternatives for Contaminated Sediments: A Coherent Decision-Making Approach. National Research Council, National Symposium on Contaminated Sediments, Washington, D.C., May 28, 1998.

Applications of Models to the Risk Assessment Problem. Chesapeake Biological Laboratory, Solomans, Maryland, November 1, 1996.

Use of Food Web Models to Evaluate Bioaccumulation Data. National Sediment Bioaccumulation Conference, Bethesda, Maryland, September 11, 1996.

Assessment and Remediation of Contaminated Sediments at Manufactured Gas Plant Sites. Electric Power Research Institute, Monterey, California, August 28, 1996.

Modeling the Environmental Fate and Transport of Metals. 26th Pellston Workshop: Reassessment of Metals Criteria for Aquatic Life Protection, Pensacola, Florida, February 11, 1996.

Toxicologically Based Ecological Risk Assessment. California EPA Workshop on Critical Issues in Assessing Ecological Risk, Asilomar, California, January 24, 1995.

Data Requirements for the Development and Use of Water Quality Models. USEPA Conference on Quality Assurance in Environmental Decision Making, IBM T.J. Watson Research Center, Yorktown Heights, New York, November 2, 1994.

Mathematical Modeling of the Bioaccumulation of Hydrophobic Organics. National Biological Survey, Columbia, Missouri, August 25, 1994.

A Model-based Evaluation of PCB Bioaccumulation in Green Bay Walleye and Brown Trout. International Association for Great Lakes Research 36th Conference on Great Lakes Research, De Pere, Wisconsin, June 7, 1993.

Bioaccumulation Modeling of Micropollutants in the Field. International Workshop on Mechanisms of Uptake and Accumulation of Micropollutants, Veldhoven, the Netherlands, May 25, 1993.

Keynote Presentation. National Institute of Environmental Health Sciences-sponsored Workshop on the Bioaccumulation of Hydrophobic Organic Chemicals in Aquatic Organisms, June 29, 1992.

Modeling the Role of Bacteria in Carbon Cycling. Gordon Research Conference, New Hampton, New Hampshire, June 17, 1992.

Calcium Magnesium Acetate Biodegradation and its Impact on Surface Waters. Symposium on the Environmental Impact of Highway Deicing, University of California, Davis, October 13, 1989.

Food Chain Modeling in the Green Bay Mass Balance Study. International Association for Great Lakes Research 32nd Conference on Great Lakes Research, Madison, Wisconsin, June 2, 1989.

Modeling the Fate of Bacteria in Aquatic Systems. American Society for Microbiology Annual Conference, New Orleans, Louisiana, May 18, 1989.

Application of a Food Chain Model to Evaluate Remedial Alternatives for PCB-contaminated Sediments in New Bedford Harbor, Massachusetts, Superfund '88, Washington, D.C., November 29, 1988.

Modeling the Accumulation of Organic Chemicals in Aquatic Animals. Joint USA/USSR Symposium: Fate of Pesticides and Chemicals in the Environment, University of Iowa, Iowa City, Iowa, November 15, 1987.

Modeling Kepone in the Striped Bass Food Chain of the James River. Virginia State Water Control Board, Richmond, Virginia, August 15, 1983.

Predicting the Effects of Toxic Chemicals in Natural Water Systems. USEPA, Environmental Research Lab, Athens, Georgia, November 3, 1982.

Modeling Toxic Substances in Aquatic Food Chains. Clarkson College Environmental Engineering Graduate Program, Potsdam, New York, October 29, 1982.

Predicting the Effects of Toxic Chemicals in Natural Water Systems. USEPA, Environmental Research Lab, Gulf Breeze, Florida, September 13, 1982.

Modeling of Fate of Toxic Chemicals in Aquatic Systems. USEPA, Office of Toxic Substances, Washington, D.C., March 16, 1982.

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Use of a Bioaccumulation Model of p,p'DDE and Total PCB in Birds as a Diagnostic Tool for Pathway Determination in Natural Resource Damage Assessments. Glaser, D. and J.P. Connolly, Continental Shelf Res. In press.

Modeling of Flood and Long-Term Sediment Transport Dynamics in Thompson Island Pool, Upper Hudson River. Ziegler, C.K., P. Israelsson and J.P. Connolly, Water Quality and Ecosystem Modeling 1:193-222, 2000.

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The Use of Ecotoxicology and Population Models in Natural Remediation. D. Glaser and J.P. Connolly, In: Natural Remediation of Environmental Contaminants: Its Role in Ecological Risk Assessment and Risk Management, Swindoll, C.M., R.G. Stahl & S.J. Ells, eds., SETAC Press, 472 p., 2000.

A Model of PCB Fate in the Upper Hudson River. Connolly, J.P., H.A. Zahakos, J. Benaman, C.K. Ziegler, J.R. Rhea and K. Russell, Environ. Sci. Technol. 34:4076-4087, 2000.

Modeling the Fate of Pathogenic Organisms in the Coastal Waters of Oahu, Hawaii. Connolly, J.P., A.F. Blumberg and J.D. Quadrini, J. Environ. Eng. 125:398-406, 1999.

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The Use of Vertical Groundwater Circulation Technology: A Preliminary Analysis of the Fate and Transport of Polycyclic Aromatic Hydrocarbons in a Shallow Aquifer. Connolly, J.P. and J.D. Quadrini, In: In Situ Bioremediation and Efficacy Monitoring, Spargo, B.J. ed., Naval Research Laboratory, NRL/PU/6115-96-317, 1996.

A Model of Carbon Cycling in the Planktonic Food Web. Connolly, J.P. and R.B. Coffin, J. Envir. Eng. 121:682-690, 1995.

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The Relationship between PCBs in Biota and in Water and Sediment from New Bedford Harbor: A Modeling Evaluation. Connolly, J.P., In: Persistent Pollutants in the Marine Environment, C.H. Walker and D. Livingstone, eds., Pergamon Press, Inc., 1991.

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A Post Audit of a Lake Erie Eutrophication Model. DiToro, D.M., N.A. Thomas, C.E. Herdendorf, R.P. Winfield and J.P. Connolly, J. Great Lakes Res. 13(4):801-825, 1987.

Movement of Kepone (Chloradecone) Across an Undisturbed Sediment-Water Interface in Laboratory Systems. Pritchard, P.H., C.A. Monti, E.J. O'Neill, J.P. Connolly and D.G. Ahearn, Environ. Tox. Chem., 5:647-658, 1986.

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A Model of Kepone in the Striped Bass Food Chain of the James River Estuary. Connolly, J.P. and R. Tonelli, Estuarine, Coastal & Shelf Science 20:349-366, 1985.

Predicting Single Species Toxicity in Natural Water Systems. Connolly, J.P., Environ. Tox. Chem. 4:573-582, 1985.

WASTOX, A Framework for Modeling Toxic Chemicals in Aquatic Systems, Part II: Food Chain. Connolly, J.P. and R.V. Thomann, U.S. Environmental Protection Agency, Gulf Breeze, FL, EPA 600/3-85-017, 1985.

A Model of PCB in the Lake Michigan Lake Trout Food Chain. Thomann, R.V. and J.P. Connolly, Environ. Sci. Tech. 18(2):65-71, 1984.

WASTOX, A Framework for Modeling Toxic Chemicals in Aquatic Systems. Connolly, J.P. and R.P. Winfield, U.S. Environmental Protection Agency, Gulf Breeze, FL, EPA 600/3-84-077, 1984.

Adsorption of Hydrophobic Pollutants in Estuaries. Connolly, J.P., Armstrong, N.E. and R.W. Miksad, ASCE J. Envir. Eng. Div. 109(1):17-35, 1983.

Calculated Contribution of Surface Microlayer PCB to Contamination of the Lake Michigan Lake Trout. Connolly, J.P. and R.V. Thomann, J. Great Lakes Research 8(2):367-375, 1982.

Mathematical Modeling of Water Quality in Large Lakes, Part 2. Di Toro, D.M. and J.P. Connolly, Lake Erie, U.S. Environmental Protection Agency, Ecological Research Series, EPA-600/3-80-065, 1980.

The Effect of Concentration of Adsorbing Solids on the Partition Coefficient. O'Connor, D.J. and J.P. Connolly, Water Research 14(10):1517-1523, 1980.

# PETER H. ISRAELSSON, Ph.D.

**Senior Managing Engineer**

## PROFESSIONAL HISTORY

Anchor QEA, LLC, Senior Managing Engineer, 2011 to present
Anchor QEA, LLC, Managing Engineer, 2007 to 2011
Massachusetts Institute of Technology, Lecturer, Spring 2010
Massachusetts Institute of Technology, Research Assistant, 2001 to 2007
Quantitative Environmental Analysis, LLC, Senior Project Engineer, 2000 to 2001
Quantitative Environmental Analysis, LLC, Project Engineer, 1998 to 2000
Omni Environmental Corporation, Staff Engineer, 1995 to 1997
Opsis Inc., Summer Intern, 1992 to 1994

## EDUCATION

Massachusetts Institute of Technology, Ph.D., Environmental Fluid Mechanics, 2008
Massachusetts Institute of Technology, S.M., Technology and Policy, 2008
Massachusetts Institute of Technology, M.Eng., Water Quality and Environmental Engineering, 1998
Lafayette College, B.A., Environmental Engineering, 1995
Lafayette College, B.A., English, 1995

## EXPERIENCE SUMMARY

The major focus of Dr. Peter Israelsson's 10 years in environmental consulting has been on contaminated sediment sites, specifically on characterizing sediment and contaminant dynamics via numerical modeling and environmental data analysis in support of conceptual site model development, remedial design, risk assessment, and source identification. Dr. Israelsson is experienced in all phases of numerical model development, and has worked on an array of surface water systems, including riverine, estuarine, and marine settings. Recent efforts include a kinetic-sorption-based fate and transport model which overcomes the limitations of traditional equilibrium-based models in a computationally tractable manner, and a novel up-scaling approach to parameterizing sub-grid concentration gradients in near-surface sediments. His expertise in fluid mechanics, sediment transport, and contaminant fate allows him to effectively manage investigations of complex systems.

In 2007, Dr. Israelsson rejoined Anchor QEA, LLC (Anchor QEA) after conducting PhD research in environmental fluid mechanics at the Massachusetts Institute of Technology (MIT). His research was focused on several modeling aspects of the sequestration of carbon dioxide ($CO_2$) by direct injection to the deep ocean—a proposed climate change mitigation strategy. This research included the development of a novel Lagrangian random-walk modeling technique that allows for the efficient characterization of residence times throughout an ocean general circulation model domain, as well as an assessment of the expected acute biological impacts due to several plausible injection schemes. In addition, Dr. Israelsson has conducted graduate work in hydrodynamic and chemical fate modeling of organic pollutants in an urban harbor environment. Beyond his technical training, Dr. Israelsson has a Master's degree in technology policy, with an emphasis on trans-boundary environmental problems and international environmental negotiation.

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Prior to his involvement with Anchor QEA, Dr. Israelsson worked on a variety of environmental investigations at Omni Environmental Corporation. Projects included water quality modeling studies, industrial and municipal permitting, treatment technology recommendations, development of geographic information system (GIS) databases, and surface water and groundwater water quality monitoring studies. Dr. Israelsson also directed several field studies.

### REPRESENTATIVE PROJECT EXPERIENCE (PROFESSIONAL)

**Construction of a PCB Fate and Transport Model for Simulation of Dredging Impacts and Long-term Recovery in the Upper Hudson River, Client: General Electric Company**

Dr. Israelsson co-managed the development of the hydrodynamic, sediment transport, and polychlorinated biphenyl (PCB) fate and transport submodels of the Upper Hudson River modeling framework for assessing the impact of past and future remedial action. The original framework developed in the late 1990s was extensively revamped to capitalize on advancements in the field of contaminated sediments and in computational technology, as well as an extensive database of PCB concentrations in sediments, water, and fish. A key emphasis of the modeling effort is simulation of the fate of resuspended dredge material and its impact on post-dredging PCB export from the system.

**Technical Advisor on the Development of a Sediment Transport and Contaminant Fate and Transport Model of the Lower Passaic River, Client: LPR Small Parties Group**

Dr. Israelsson assisted in the coordination of the Modeling Subcommittee of the Cooperating Parties Group's (CPG's) Technical Committee on behalf of the Lower Passaic River Small Parties Group. This subcommittee has the objective of providing the CPG TC with a clear understanding of model development status, aiding in decision-making on modeling issues, and supporting CPG's interactions with the USEPA on Lower Passaic River modeling issues.

**Analysis of Contaminant Dynamics in the Lower Passaic River, Client: LPR Small Parties Group**

Dr. Israelsson co-directed an in-depth analysis of contaminant dynamics in the Lower Passaic River, with particular emphasis on the relative importance of present and historical loadings for the major contaminants of concern at the site. A detailed conceptual site model was constructed by integrating multiple data types (e.g., sediment contaminant concentration data, geochronological core profiles, tidal data, salinity patterns, and sediment type) to help characterize the expected relative efficacy of various remedial strategies.

**Modeling of Historical Contaminant Export from a Tidal System, Client: Confidential**

Dr. Israelsson directed the construction of a coupled hydrodynamic, sediment transport, and contaminant transport model to evaluate the historical export of sediment-bound contaminants from a tidal system. A key challenge was developing a tool appropriate for quantifying mass export despite the limited data available to constrain historical sediment and contaminant loadings.

**Analysis of Stormwater Impacts on an Urban Harbor, Client: Confidential**

Dr. Israelsson evaluated site data for an industrial urban harbor for evidence of municipal stormwater contributions to legacy-contaminated sediments. The work centered on building an empirically based conceptual site model in preparation for a more detailed modeling study. A multidisciplinary weight-of-evidence approach was successfully applied to identify areas likely impacted by stormwater loadings; thus, providing a means of focusing future work on the site.

**Analysis of the Fate of PCBs in the Upper Hudson River, Client: General Electric Company**

Dr. Israelsson assisted in the development of the original (circa 1999-2001) hydrodynamic and sediment transport model of the Upper Hudson River, New York. His responsibilities included model calibration and validation, data analyses, and results dissemination. Dr. Israelsson was also involved in the creation and maintenance of an extensive GIS database for the Upper Hudson River.

**Assessment of Sediment Resuspension and PCB Release during Dredging Activities, Client: General Electric Company**

Dr. Israelsson coordinated an analysis of the potential for the release of PCBs due to sediment resuspension during dredging of the Upper Hudson River as part of a response to a remedial plan proposed by USEPA. The analysis included the development of a conceptual model of PCB release during dredging, demonstrating the potential for downstream migration of desorbed PCBs.

**Development of a PCB Fate and Transport Model for the Lower Fox River, Client: U.S. Fish and Wildlife Service**

Dr. Israelsson assisted in the development of a hydrodynamic, sediment transport, and PCB fate model of the Lower Fox River (below Depere) in Wisconsin. His responsibilities included model calibration and validation, data analyses support, and results dissemination.

**Characterization of PCB Sources and Fate in the Lower Grasse River, Client: Alcoa**

Dr. Israelsson assisted in the development of a hydrodynamic, sediment transport, and PCB fate model of the Lower Grasse River near Massena, New York. His responsibilities included model code development, calibration and validation, data analyses support, and results dissemination.

**Analysis of the Fate of PCBs in the Housatonic River, Client: General Electric Company**

Dr. Israelsson assisted in the development of a PCB fate model of the Housatonic River. His responsibilities included model code development and initial model calibration. The project required the development of an innovative grid collapse scheme to allow practical simulation of PCB transport during flooding conditions.

## PETER H. ISRAELSSON, Ph.D.

**Senior Managing Engineer**

**Addressing the Federal Ocean Discharge Criteria, Client: Ocean County Utilities Authority, New Jersey**

Dr. Israelsson compiled historical data on ocean wastewater discharges for input to preliminary dilution modeling. His work identified environmentally sensitive areas that may potentially be affected by discharged effluent, and assessed possible risks of bioaccumulation of toxic chemicals. Dr. Israelsson supervised a reconnaissance survey and main field study to collect water quality and benthic macroinvertebrate samples along the affected coastline.

**Groundwater Protection Plan, Client: Evesham Municipal Utilities Authority, New Jersey**

Dr. Israelsson drafted a groundwater protection plan for submission to the New Jersey Department of Environmental Protection as part of a New Jersey Pollutant Discharge Elimination System permit renewal process for a wastewater treatment facility. Historical discharge and groundwater monitoring data were used to assess the effectiveness of the facility's spray irrigation system. The water quality monitoring program was refined to be more useful and cost-efficient, and a revised permit was prepared. Dr. Israelsson also drafted a similar plan for an industrial client.

**Water Distribution System Analysis, Client: Confidential**

Dr. Israelsson created a series of GIS databases that showed the historical evolution of an urban water distribution system in order to analyze long-term trends in water supply and historical contamination levels and loads to various regions of the system.

**Application for Discharge Allocation Certificate, Client: Mount Holly Sewerage Authority, New Jersey**

Dr. Israelsson assisted in compiling and analyzing historical watershed data, executing a three-phase field survey, analyzing sampling results, preparing water quality model input, and analyzing model results. An extensive GIS database of the sewer service area was created for analysis of local land usage, regional soil types, major groundwater aquifers, and historical and environmentally protected areas.

**Silver Discharge Permitting, Client: Gannett Newspapers**

Dr. Israelsson worked on two projects involving treatment technology recommendations and permitting of photograph-processing operations associated with major newspaper production.

**Strawbridge Lake Restoration and Wetlands Mitigation Project, Client: Township of Moorestown, New Jersey**

Dr. Israelsson assisted in the design of pocket wetlands to treat urban runoff to a lake system and slope stabilization schemes to prevent shoreline erosion. The study required delineating precise drainage areas and creating a water balance for reservoir routing calculations. Soil bioengineering techniques were researched and implemented in slope stabilization, and modifications to local storm sewer discharges were recommended. Local volunteer efforts were organized to help lower implementation costs.

### Water Quality Assessment, Client: Township of West Windsor, New Jersey

Dr. Israelsson prepared a quantitative and qualitative assessment of the general surface water quality in a small urban watershed. He compiled and analyzed historical water quality data and made general recommendations for reducing contaminant loads. In addition, a public education brochure was created for distribution to township citizens.

## REPRESENTATIVE RESEARCH EXPERIENCE (ACADEMIC)

### Development of an OGCM-based Lagrangian Random-Walk Model with Applications of Simulating Deep Ocean Sequestration of Carbon Dioxide by Direct Injection, Academic Institution: MIT

Dr. Israelsson conducted novel research to develop a random-walk-based particle tracking model for conducting global-scale tracer transport simulations aimed at efficiently characterizing residence times for all computational cells within an Ocean General Circulation Model (OGCM). The random-walk approach was adapted to be compatible with the tracer transport framework of a specific OGCM, the Lawrence Livermore National Laboratory Modular Ocean Model (LLNL MOM). Key challenges encountered within this framework, which are thought to be common to most coarse-gridded OGCMs, include diffusion along isopycnal surfaces, the Gent-McWilliams skew diffusive flux, and vertical diffusion in the presence of extreme and discontinuous gradients in diffusivity induced by convective instability. For the latter issue, a novel particle reflection technique was created that allows for greatly enhanced computational efficiency by overcoming the need for a very small time step in such regimes. The resulting model was applied to simulate tracer transport with particles, and a technique was developed by which particle trajectories can be sampled repeatedly to infer residence times across large portions of the computational domain. The model and post-processing technique was applied to simulate the $CO_2$ sequestration efficiency of the world's oceans across a range of depths; sequestration efficiency would be a key consideration in site selection for deep ocean carbon sequestration by direct injection approaches to mitigating climate change. This work was conducted in collaboration with researchers at LLNL and the Carnegie Institute's Department of Global Ecology.

### Investigation of the Acute Biological Impacts of Deep Ocean Carbon Sequestration by Direct Injection, Academic Institution: MIT

Dr. Israelsson's research was aimed at understanding the expected near to intermediate field biological impacts of several promising schemes for ocean carbon sequestration by direct injection of $CO_2$. The work consisted of an extensive literature review of $CO_2$ toxicity data and simulation of hypothetical discharges. Three discharge approaches were considered to maximize dilution over the water column, two of which take advantage of the enhanced dilution offered by $CO_2$ hydrate particles based on recent research on the formation and behavior of such particles. Evaluations were conducted within a framework consisting of multiple coupled sub-models, which collectively simulated the discharge plume (via analytical solutions), organism trajectories through the plume (via a distance-neighbor random-walk technique), and the organism toxicological response to the time-variable $CO_2$ exposure (via an isomortality or integrated probit model). Overall, results suggest that it is possible with present or near-present technology to engineer discharge configurations that achieve sufficient dilution to largely avoid acute impacts. In addition to lethal effects, sub-lethal and ecosystem effects were considered qualitatively, though not analyzed quantitatively. Results were also considered within a policy context. The main conclusion from this work was that ocean carbon sequestration by direct injection should not be dismissed as a climate change mitigation strategy on the basis of environmental impact alone; rather, it can be considered as a viable option for further study, especially in regions where geologic sequestration proves impractical. This work was conducted under a grant from the U.S. Department of Energy.

**Construction of a PAH Fate and Transport Model in Boston Harbor, Academic Institution: MIT**

Dr. Israelsson constructed a three-dimensional fate and transport model of polycyclic aromatic hydrocarbons (PAHs) for Boston's Inner Harbor. The model was based on the Estuarine, Coastal, and Ocean Model (semi-implicit; ECOM-si) framework, with some modification to allow for decay processes relevant to the target PAHs (i.e., naphthalene, pyrene, and benzo(a)pyrene). The impact of external sources relative to the internal sediment source was considered, and crude model validation was provided by comparison to PAH concentration measured from deployed semi-permeable membrane devices. Model results suggested that the sediment PAH source was dominant, and water column responses to several remedial strategies was investigated using the model. This work was conducted in collaboration with MIT's Sea Grant Program.

### *Publications*

Random Walk Particle Tracking in Step and Piecewise Linear Diffusivity. Israelsson, P.H. and E.E. Adams. In preparation.

Residence Time Estimation in an Ocean General Circulation Model with a Random Walk Particle Tracking Method. Israelsson, P.H., E.E. Adams, and K. Caldeira. In preparation.

An Updated Assessment of the Acute Impacts of Ocean Carbon Sequestration by Direct Injection. Israelsson, P.H., A.C. Chow, and E.E. Adams. International Journal of Greenhouse Gas Control, 4(2): 262-271. 2010.

An Updated Assessment of the Acute Impacts of Ocean Carbon Sequestration by Direct Injection. Israelsson, P.H., A.C. Chow, and E.E. Adams. Conference Proceedings of the 9th International Conference on Greenhouse Gas Control Technologies. Washington DC, November, 2008. (This version is superseded by the International Journal of Greenhouse Gas Control 2010 version).

Studies of Lagrangian Modeling Techniques with Applications to Deep Ocean Carbon Sequestration. PhD Thesis, Department of Civil and Environmental Engineering, Massachusetts Institute of Technology. 2008.

Evaluation of the Environmental Viability of Direct Injection Schemes for Ocean Carbon Sequestration. Israelsson, P.H. and E.E. Adams. U.S. Department of Energy Report, October, 2007.

A Comparison of Three Lagrangian Approaches for Extending Near Field Mixing Calculations. Israelsson, P.H., Y.D. Kim, and E.E. Adams. Environmental Modeling and Software, 21(12): 1631-1649. 2006.

The Contingent Agreement Approach to the Negotiation of Multilateral Environmental Agreements. Israelsson, P.H. In Negotiating a Sustainable Future: Innovations in International Environmental Negotiation, Volume 12. Eds. Lawrence E. Susskind, William R. Moomaw, and Kristin M. Kurczak. Cambridge: PON Books. 223-260. 2003.

Impacts of a Rare Flood Event on PCB Fate and Transport in Thompson Island Pool, Upper Hudson River. Israelsson, P.H., C.K. Ziegler, H.A. Zahakos, and J.P. Connolly. In Proceedings of the 33rd Annual Mid-Atlantic Industrial and Hazardous Waste Conference, Ed. N. Assaf-Anid. New York: Technomic. 3-12. 2001.

Modeling Sediment Transport Dynamics in Thompson Island Pool, Upper Hudson River. Ziegler, C.K., P.H. Israelsson, J.P. Connolly. Water Quality and Ecosystem Modeling, 1:193-222. 2000.

3D Mass Balance Model of PAHs in Boston's Inner Harbor. Petroni, R.N. and P.H. Israelsson. MIT MEng Thesis in Civil & Environmental Engineering. 1998.

Complying with the Federal Ocean Discharge Criteria and New Jersey's Coastal Watershed Approach. Obropta, C.C. and P.H. Israelsson. WEF Watershed and Wet Weather Technical Bulletin. July 1997.

Modeling the Effects of Rooted Macrophytes on Instream Dissolved Oxygen in the North Branch Rancocas Watershed. Cosgrove, Jr., J.F. and P.H. Israelsson. WEF Conference Proceedings of Watershed '96. 1996.

# PETER OATES, PH.D.

**Senior Engineer**

## PROFESSIONAL HISTORY

Anchor QEA, Senior Engineer, 2010 to Present
Anchor QEA, Project Engineer, 2009 to 2010
Quantitative Environmental Analysis, LLC, Project Engineer, 2007 to 2009

## EDUCATION

Massachusetts Institute of Technology, Ph.D., Civil and Environmental Engineering, 2007
Massachusetts Institute of Technology, M.E., Environmental and Water Quality Engineering, 2001
Columbia University, B.S., Earth and Environmental Engineering, 2000
Fairfield University, B.A., Liberal Arts, 1998

## EXPERIENCE SUMMARY

Dr. Oates specializes in the development and implementation of mathematical models that describe and predict chemical transport and reaction in surface water and groundwater. At Anchor QEA, he has co-founded advancements in the state-of-the-field theory for mechanisms influencing long-term sediment recovery: 1) Desorption Kinetics: chemical desorption time-scales are typically longer than particle residence times, implying the commonly applied equilibrium assumption is problematic; and 2) Microscale Theory: numerical grid models typically cannot resolve the true near-surface chemical concentration driving the bed/water-column exchange. These theories have been applied to enhance the predictive ability of models Anchor QEA has developed for CERCLA sites.

Dr. Oates has teamed up with Columbia University to study arsenic laden groundwater in rural South Asia, which the United Nations has called the single worst case of mass poisoning in human history. He is technical lead for developing and calibrating a groundwater and surface water model for Van Phuc, Vietnam. Modeling to date suggests that the younger river water may be the tied to the governing arsenic release mechanisms. He has also developed and implemented groundwater flow and transport models of arsenic in Bangladesh, bioluminescent bacteria, and chromium-contaminated colloids. Dr. Oates' doctoral work focused on understanding and modeling how slow mixing in groundwater can control overall chemical reaction rates, and how the lack of mixing can cause chemical concentrations in aquifers to be spatially variable. He has conducted field and laboratory research in Haiti, Bangladesh, Waquot Bay, and at Sandia National Laboratories.

Along with code development, Dr. Oates is proficient in using MODFLOW, a U.S. Geological Survey (USGS) groundwater hydrodynamic model; RT3D, a groundwater fate and transport model; and FEFLOW, an advanced finite element groundwater flow and transport model. He is also well acquainted with statistical methods techniques in environmental sciences.

## REPRESENTATIVE PROJECT EXPERIENCE

## PETER OATES, PH.D.

**Senior Engineer**

### Analyses of PCB Fate in the Hudson River, General Electric Company

Dr. Oates served as co-manager for the re-calibration and refinement of Anchor QEA's PCB fate model for the Upper Hudson River, in order to develop a tool suitable for assessing the impact of past and future remedial action. The model development focused on taking advantage of the extensive sediment and water column monitoring dataset that has been collected over the past decades, which includes data from before, during, and after active remediation periods.

### Contaminant Reaction and Transport in Porous Medium, Confidential

Dr. Oates supported research and development efforts for a major industrial client on a new process involving oxidation reactions for purification of a porous material. He led the development of a conceptual and mathematical model and assisted with an in-depth data analysis to investigate hypothesized reaction and transport pathways. The approach focused on intra-particle and inter-particle pathways and contaminant reaction and transport, resulting in a dual second-order model.

### Groundwater-Surface Water Modeling in Vietnam, Columbia University

Dr. Oates was technical lead for developing and calibrating a groundwater-surface water flow and transport model to predict groundwater age distributions for Van Phuc, Vietnam. The model combines the USGS codes MODFLOW, MT3D, and RIVER package. This model is expected to be applied to studies governing arsenic release mechanisms, arsenic fate and transport, and potential arsenic mitigation scenarios.

### Development of Groundwater Surface Water Interface Model, ExxonMobil, Inc.

Dr. Oates assisted in the development of a complex interface model for simulating the holistic transport and transformation of multiple hydrocarbon species from upland sources to surface water bodies, including the exchanges across the transition zone. The interface model combines USGS code SEAWAT for subsurface fate and transport and AQFATE, Anchor QEA's in-house code built upon the EFDC platform, for modeling hydrodynamics, sediment and chemical fate, and transport in surface waters. This model is expected to be applied across several ExxonMobil sites.

### Analyses of Hydrodynamics in the Grasse River, Alcoa, Inc.

Dr. Oates was task leader for recalibration of Anchor QEA's hydrodynamic model, which is used to evaluate various alternatives for the management of PCBs in the sediments of the Grasse River.

### Statistical Analysis of Sub-Aquatic Vegetation Success Criterion for Hudson River, General Electric Company

Dr. Oates assisted in the development of a statistical success criterion to determine when sub-aquatic vegetation has been sufficiently restored after dredging. A bootstrapping approach was taken using R.

## PETER OATES, PH.D.

**Senior Engineer**

### Statistical Analysis of Background PCB Load for Hudson River, General Electric Company

Dr. Oates assisted in the development of determining the 95% upper confidence limit on the background load levels during dredging through bootstrapping.

### Air Modeling of the Hudson River, General Electric Company

Dr. Oates developed an analytical model to predict air concentrations of PCBs for comparison against control standards to assess if air pollution would be an issue during dredging.

### Anchor QEA Code Benchmark and Development

Dr. Oates assisted in the development of analytical solutions and the benchmarking and development of Anchor QEA's own PCB fate and transport code.

### Development of a New Method for Modeling Reactive Transport in Groundwater, Academic Research at Massachusetts Institute of Technology and Sandia National Laboratories

Dr. Oates conducted novel experiments in clear homogeneous and heterogeneous porous media with colorimetric chemical reactions to demonstrate the inadequacy of current groundwater reactive transport models. He developed a new solute transport modeling approach that correctly approximates the full concentration distributions for both conservative and reactive transport in porous media. He also observed and modeled how chemical reactions can alter solute diffusion coefficients and lead to density instabilities that drive large-scale flow.

### Thermal Imaging of Waquoit Bay, Academic Research at Massachusetts Institute of Technology

Dr. Oates studied groundwater discharge by comparing thermal images taken from a blimp, temperature measurements from a kilometer-long thermometer, and direct flux measurements from seepage meters. He also conducted bromide tracer tests to examine solute fate and transport.

### Groundwater Dynamics and Arsenic Contamination in Bangladesh, Academic Research at Massachusetts Institute of Technology

Dr. Oates conducted and modeled reactive push-pull experiments to examine factors controlling arsenic concentrations in groundwater. He helped develop a large-scale model of groundwater dynamics.

### Public Supply Well Contamination in Rhode Island, HydroAnalysis

Dr. Oates assessed whether public supply wells in Rhode Island withdraw contaminated river water by conducting flow and hydraulic gradient testing with seepage meters and a differential head sampler, respectively.

### Modeling Fate and Transport of Bioluminescent Bacteria in Porous Media, Academic Research at Massachusetts Institute of Technology

Dr. Oates developed a reactive transport model for bioluminescence resulting from bacterial contaminant degradation during flow and transport in clear porous media.

**Modeling Chromium-Contaminated Colloid and Bromide Transport in Groundwater, Academic Research at Massachusetts Institute of Technology**

Dr. Oates modeled reactive and conservative push-pull tests to show how injecting sodium citrate mobilized chromium-contaminated colloids and altered aquifer properties.

**Solar Disinfection for Point-of-Use Water Treatment in Haiti, Academic Research at Massachusetts Institute of Technology**

Dr. Oates conducted field work for one month at several locations in Haiti to examine the feasibility and efficacy of using plastic bottles to disinfect water by means of the synergistic effects of sunlight-induced microbial DNA alteration, photo-oxidative destruction, and thermal inactivation. He demonstrated that this solar disinfection-based technology produced disease-free water at the cost of a plastic bottle.

**Chaotic Advection Enhanced Natural Attenuation of Groundwater, Academic Research at Columbia University**

Dr. Oates worked on an innovative idea for groundwater remediation. He worked in collaboration with three departments using numerical modeling to demonstrate that oscillating wells will create superior remedial mixing in an aquifer.

## PROFESSIONAL ACTIVITIES

### Affiliations

Member of Sigma Chi (Massachusetts Institute of Technology Chapter)
Tau Beta Pi (Columbia University Chapter)
American Geophysical Union
National Ground Water Association
American Society of Civil Engineers
Environmental Defense Fund

## PRESENTATIONS

Upscaling Reactive Transport in Porous Media. Oates, P.M. and C.F. Harvey, EPA STAR Conference, Washington D.C., October 2006.

Upscaling Reactive Transport in Porous Media. Oates, P.M. and C.F. Harvey, Gordon Research Conference on Flow and Transport in Permeable Media, Andover, New Hampshire, July 2006.

Visualization of Reactive Transport. Harvey, C.F. and P.M. Oates, Gordon Research Conference on Flow and Transport in Permeable Media, Andover, New Hampshire, July 2006.

Upscaling and Uncertainty of Reactive Transport in Heterogeneous Porous Media. Oates, P.M., C.F. Harvey, L. Meigs, and R. Haggerty, AGU, San Francisco, California, December 2004.

Direct Visualization of Reactive Transport: Mixing at the Pore-Scale and at the Darcy-Scale. Conceptual Model Development for Subsurface Reactive Transport Modeling of Inorganic Contaminants, Radionuclides, and Nutrients. Oates, P.M., C.F. Harvey, L. Meigs, and R. Haggerty, U.S. Federal Interagency Workshop, Albuquerque, New Mexico, April 20 to 22, 2004.

Do Seepage Meters Suck: Downwelling observations in coastal sediments and laboratory analysis of the bag-type seepage meter. Slaby, E.F., P.M. Oates, and H.F. Hemond, Gordon Conference on Permeable Sediments. Bates College, Lewiston, Maine, June 2003.

Reactive Upscaled Subsurface Transport Using Mass Transfer and Dispersion. Oates P.M., C. Freiherr von Schwerin, C.F. Harvey, and L. Meigs, EGS-AGU-EUG Joint Assembly, Nice, France, April 6-11, 2003.

The Role of Diffusion in Solute Transport and Reaction in Porous Media: Results from Direct Visualization of Laboratory Experiments. Harvey, C.F., L. Meigs, B. Zinn, P.M. Oates, C. Freiherr von Schwerin, C. Gramling, and R. Haggerty, Fall AGU, San Francisco, California, 2002.

Arsenic Mobility in a Bangladeshi Aquifer. Harvey, C.F., C.H. Swartz, A.B.M. Badruzzaman, N. Keon-Blute, W. Yu, M.A. Ali, J. Jay, R. Beckie, V. Niedan, D. Brabander, P.M. Oates, K.N. Ashfaque, S. Islam, H.F. Hemond, and M.F. Ahmed, Gordon Research Conference, Spring 2002.

Upscaled Subsurface Transport Using Mass Transfer and Dispersion. Oates, P.M., C. Freiherr von Schwerin, C.F. Harvey, and L. Meigs, Reactive Sandia National Laboratories, December 2002.

Reactive Transport: The difference between Laboratory and Modeled Results. Harvey, C.F., L. Meigs, B. Zinn, P.M. Oates, C. Freiherr von Schwerin, C. Gramling, and R. Haggerty, AGU/EGU/IHS, Berkeley University, March 2002.

Reactive Transport: Why Laboratory and Modeled Behavior Differs, "Bridging the Gap between Measurement and Modeling in Heterogeneous Media" Harvey, C.F., L. Meigs, B. Zinn, P.M. Oates, C. Freiherr von Schwerin, C. Gramling, and R. Haggerty, International Groundwater Symposium organized by IAHR and co-sponsored by IAHS, AGU, and ASCE/EWRI, Berkeley University, March 2002.

Arsenic Mobility in Bangladesh. Arsenic in Drinking Water. Harvey, C.F., C.H. Swartz, A.B.M Badruzzaman, N. Keon-Blute, W. Yu, M.A. Ali, J. Jay, R. Beckie, V. Niedan, D. Brabander, P.M. Oates, K.N. Ashfaque, S. Islam, H.F. Hemond, and M.F. Ahmed, An International Conference. Columbia University, New York, New York, November 2001.

The Arsenic Crisis in Bangladesh. Harvey, C.F., C.H. Swartz, A.B.M. Badruzzaman, N. Keon-Blute, W. Yu, M.A. Ali, J. Jay, R. Beckie, V. Niedan, D. Brabander, P.M. Oates, K.N. Ashfaque, S. Islam, H.F. Hemond, and M.F. Ahmed, NSF Joint United States/Bangladesh Workshop on the future of the Ganges-Brahamaputra Delta, November 2001.

Quantification of Transport of Solutes Across the Porous Bed-Stream Water Interface with Tracer Tests. Bagtzoglou, A.C., F. El-Habel, and P.M. Oates, AGU. San Francisco, California, December 2001.

Chaotic Advection in Groundwater and Implications Regarding Aquifer Remediation. Oates, P.M., A.C. Bagtzoglou, and R. Chevray, Fifth World Conference on Experimental Heat Transfer and Fluid Mechanics and Thermodynamics, Thessaloniki, Greece, September 2001.

Chaotic Advection Enhanced Natural Attenuation. Oates, P.M., A.C. Bagtzoglou, and R. Chevray. Joint ASCE-EWRI Conference on Water Resources Engineering, Minneapolis, Minnesota, August 2000.

Chaotic Advection Enhanced Natural Attenuation. Oates, P.M., A.C. Bagtzoglou, and R. Chevray, AGU, San Francisco, California, December 2000.

## PUBLICATIONS

Delayed contamination of an aquifer with high-arsenic groundwater drawn by groundwater pumping: a temporal reconstruction at a geological transition. van Geen, A., B.C. Bostick, Pham Thi Kim Trang, Vi Mai Lan, Nguyen-Ngoc Mai, Phu Dao Manh, Pham Hung Viet, K. Radloff, Z. Aziz, J.L. Mey, M.O. Stahl, C.F. Harvey, P. Oates, B. Weinman, C. Stenge, F. Frei, R. Kipfer, M. Berg. Nature (In review).

Reactive Mixing in Porous Media. Oates, P.M., C. Freiherr von Schwerin, C.F. Harvey, and L. Meigs, Nature (In preparation).

Reactive Density Fingering in Porous media. Oates, P.M., C. Freiherr von Schwerin, C.F. Harvey, and L. Meigs. Journal of Fluid Mechanics (In preparation).

Upscaling and Uncertainty of Reactive Transport in Porous Media 3: Production-Destruction Balances, Taylor Series, and Practical Considerations for the CF-β Model. Oates, P.M. and C.F. Harvey. Water Resources Research (In preparation).

Upscaling and Uncertainty of Reactive Transport in Porous Media 2: Development and Experimental Validation of the Concentration Fluctuation Beta-pdf (CF-β) Model. Oates, P.M. and C.F. Harvey. Water Resources Research (In preparation).

Upscaling and Uncertainty of Reactive Transport in Porous Media 1: Imaging Colorimetric Reactions in Spatially Homogeneous and Heterogeneous Material. Oates, P.M., C. Freiherr von Schwerin, C.F. Harvey, and L. Meigs. Water Resources Research (Submitted).

A Colorimetric Reaction to Absorb Light on Fluid Mixing. Oates, P.M. and C.F. Harvey. Experiments in Fluids. DOI 10.1007/s00348-006-0184-z.

On the Enhanced Groundwater Remediation Potential of Chaotic Advection. Bagtzoglou, A.C. and P.M. Oates, 2006. ASCE Journal of Materials in Civil Engineering. 19(1): 75-83.

Groundwater dynamics and arsenic contamination in Bangladesh. Harvey, C. F., K. N. Ashfaque, W. Yu, A.B.M. Badruzzaman, M. Ashraf Ali, P.M. Oates, H.A. Michael, R. B. Neumann, R. Beckie, S. Islam, and M.F. Ahmed, 2006. Chemical Geology 228:112-136.

Shedding light on reactive microbial transport in porous media: Experimental visualization and numerical modeling of Pseudomonas fluorescens 5RL bioluminescence. Oates, P.M., C. Castenson, C.F. Harvey, M. Polz, and C. Culligan, 2005. Journal of Contaminant Hydrology 77(4):233-245.

Groundwater Arsenic Contamination on the Ganges Delta: Biogeochemistry, Hydrology, Human Perturbations, and Human Suffering on a Large Scale. Harvey, C.F., C.H. Swartz, B. Badruzzman, N.E. Keon, W. Yu, A. Ali, J. Jay, R. Beckie, V. Niedan, D. Brabander, P.M. Oates, K. Ahsfaque, S. Islam, H.F. Hemond, and F. Ahmed, 2005. Comptes-Rendus: Geoscience 337(1-2):285-296.

Bromide transport before, during, and after colloid mobilization in push-pull tests and the implications for changes in aquifer properties. Hellerich A.L., P.M. Oates, C.R. Johnson, N.P. Nikolaidis, C.F. Harvey, and P.M. Gschwend, 2003. Water Resources Research 39(10):1301.

Response to comments on: Arsenic mobility and groundwater extraction in Bangladesh. Harvey, C.F., C. Swartz, A.B.M. Badruzzaman, N. Keon-Blute, W. Yu, M.A. Ali, J. Jay, R. Beckie, V. Niedan, D. Brabander, P.M. Oates, K. Ashfaque, S. Islam, H. Hemond, and M.F. Ahmed, 2003. Science 300(5619):584D-U3.

Solar Disinfection (SODIS) for Point-of-Use Water Treatment in Haiti and Simulation of Solar Radiation for Global SODIS Assessment. Oates, P.M., P. Shanahan, and M. Polz, 2003. Water Research 37(1):47-54.

Arsenic mobility and groundwater extraction in Bangladesh. Harvey, C.F., C. Swartz, A.B.M. Badruzzaman, N. Keon-Blute, W. Yu, M.A. Ali, J. Jay, R. Beckie, V. Niedan, D. Brabander, P.M. Oates, K. Ashfaque, S. Islam, H. Hemond, and M.F. Ahmed, 2002. Science 298(5598):1602-1606.

# WEN KU

**Managing Engineer**

## PROFESSIONAL HISTORY

Anchor QEA, LLC, Managing Engineer, 2010 to present
Anchor QEA, LLC, Senior Environmental Engineer, 2009 to 2010
QEA, LLC, Senior Project Engineer, 2007 to 2009
QEA, LLC, Project Engineer, 2004 to 2006
QEA, LLC, Engineer, 2000 to 2004
University at Buffalo, Research Assistant, 1998 to 1999
University at Buffalo, Teaching Assistant, 1998
National Taiwan University, Research Assistant, 1994 to 1995

## EDUCATION

State University of New York at Buffalo, M.S., Civil Engineering, 2000
National Taiwan University, B.S., Atmospheric Sciences, 1995

## EXPERIENCE SUMMARY

Mr. Ku is an environmental engineer with more than 14 years of experience in the field. His experience has focused on the analysis of contaminants and their fate and transport in surface water systems, including statistical and graphical analyses of data and the development of mechanistic mathematical models, as well as the application of these models to assist evaluation and design or remedial alternatives. Mr. Ku also has extensive experience using Geographical Information System (GIS) and has developed custom GIS applications for the assessment of potential remedial alternatives. Mr. Ku is also proficient in the use of Interactive Data Language (IDL) for data analyses, data management, and data visualization.

Mr. Ku also has extensive experience in the area of sediment transport. His graduate work focused on the sedimentation pattern at a river-dominated delta.

## REPRESENTATIVE PROJECT EXPERIENCE

### *Contaminated Sediments Assessment*

**Evaluation of Contaminant Fate and Transport in the Tittabawassee River, Michigan, The Dow Chemical Company**

Mr. Ku coordinated and implemented a multi-faceted project related to the fate and transport of various organic contaminants, including dioxins and furans, in the Tittabawassee River. These efforts included characterizing the nature and extent of contamination throughout the river sediments and bank soils and the processes governing the fate and transport of these contaminants in the river sediments, bank soils, and adjacent floodplains. He developed field sampling plans to obtain data necessary for site characterization as well as system-wide bank erosion and fate and transport models that will be used to assess and evaluate various engineering options aimed at reducing bank erosion within the system and supporting the remediation of the river sediments.

## WEN KU

**Managing Engineer**

### Evaluation of Dixon Fingerprinting in the Lower Passaic River, New Jersey, Passaic Small Parties Group

Mr. Ku was the project engineer responsible for coordinating various data analyses to understand the distribution of various contaminants within the system. He performed a Dixon and Furan fingerprint analysis to indentify sources of 2, 3, 7, 8-Tetrachlorodibenzodioxin to the lower Passaic River.

### Assessment of PCBs Release during Dredging Activities in the Upper Hudson River, New York, General Electric Company

Mr. Ku was the project engineer in charge of characterizing the amount of polychlorinated biphenyls (PCBs) released as a result of Phase 1 dredging activities and evaluating the potential factors that could have affected PCBs released due to dredging. Mr. Ku managed the findings, which were fed into a screening-level resuspension model to predict the potential for resuspension and transport of PCBs during Phase 2 dredging that aided in the dredging design.

### Housatonic River PCBs Corrective Measures Study, General Electric Company

Mr. Ku was the project engineer in charge of evaluating a set of cleanup alternatives to address PCB-impacted river sediments and floodplain soils in a Corrective Measures Study. As part of the study, Mr. Ku has updated the existing PCB fate and transport model to simulate sediment removal and capping activities and applied this numerical model to predict future reductions in water and sediment PCB concentrations that would be achieved by the alternatives. In addition, Mr. Ku developed GIS-based computations to delineate areas of floodplain soil that would need remediation to meet various risk-based cleanup goals.

### Evaluation of PCBs in the Housatonic River, Massachusetts, General Electric Company

Mr. Ku performed extensive data analyses in support of conceptual model development, including spatial and temporal trend analyses of PCB concentrations in sediments and the water column and sediment diffusive flux calculations. He assisted in a PCB fate and transport modeling effort with model input development and graphical display of model calibration results.

### Characterization of Sediment PCBs in the Upper Hudson River, General Electric Company

Mr. Ku implemented statistical analyses to evaluate the inventory of sediment PCBs using low- and high-resolution coring data. He utilized a numerical deposition model to verify the sediment mixing intensity. Mr. Ku also assisted in the development of sediment coring locations for the Upper Hudson River 2002 Sediment Sampling and Analysis Program.

### Characterization of Sediment PCBs in a Microcosm Study, Alcoa, Inc.

Mr. Ku participated in a study to evaluate sediment capping efficiency. PCB-containing river sediments were placed in small tanks and a cap was applied. He utilized a numerical model to simulate PCB depth profiles to assess the extent of PCB migration through the cap material.

## WEN KU
**Managing Engineer**

### Evaluation of PCBs in Conard's Branch/Richland Creek, Client: Viacom

Mr. Ku performed a PCB fate modeling study in Conard's Branch and Richland Creek, Indiana. His model development included extensive data analyses, model input development, and model calibration. Mr. Ku managed and integrated stage height, flow, water column, sediment, and biota datasets into a database.

### *Hydrodynamic and Sediment Transport Modeling*

### Evaluation of PCBs in the Conard's Branch and Richland Creek, Viacom, Inc.

Mr. Ku performed a hydrodynamic and sediment transport modeling study in Conard's Branch and Richland Creek, Indiana. His model development included extensive data analyses, model input development, and model calibration. The hydrodynamic and sediment transport models were linked to a PCB fate and transport model to evaluate potential remedial alternatives.

### Experimental Study of Fundamental Fluid Dynamic Controls on Delta Clinoform Morphology, National Science Foundation

Dr. Ku implemented a series of experiments to explore the sedimentation pattern in a shallow water basin and performed a flow visualization to study the flow pattern in an experimental flume.

### *Water Quality and Eutrophication Assessment*

### Onondaga Lake Ambient Monitoring Program Report, EcoLogic, L.L.C.

Mr. Ku was the project manager for the development of a section for the Seneca River water quality conditions, as part of the annual Onondaga Lake Ambient Monitoring Program (AMP) Report conducted by EcoLogic, L.L.C. This effort included coordinating data analyses, interpreting data analysis results, and developing text for the report.

### Water Quality Model of the Seneca, Oneida, and Oswego Rivers, Onondaga County Department of Water Environment Protection

Mr. Ku assisted in the creation of a water quality model, including development of model boundary conditions, evaluation of spatial and temporal trends of nutrients, and exploration of relationships between nutrient concentrations and physical characteristics in the river (e.g., temperature and flow rate). The model was used to evaluate the impact on water quality in the Seneca River due to a potential change in capacity of a wastewater treatment plant discharging to the river.

### Onondaga Lake Ambient Monitoring Program, Onondaga County Department of Water Environment Protection

Mr. Ku managed and integrated AMP datasets, compiled from various sources, into a user-friendly database. He also assisted in the development of annual AMP reports.

## WEN KU
**Managing Engineer**

***Data Integration, Management, and Visualization***

**Model User Interface, Onondaga County Department of Water Environmental Protection**

Mr. Ku managed the development of a custom application using VB and IDL for the client and other interest parties to perform model simulations to evaluate a series of management decisions. This application creates input files for the Onondaga Lake Water Quality Model and Three River Water Quality Model based on user-specified remedial alternatives and future river and lake conditions, as well as generates graphics for simulation results.

**Soil Cleanup Level Assessment, Confidential Client**

Mr. Ku developed a custom GIS tool using VBA, ArcObjects, and the ArcView Spatial Analyst extension to evaluate potential remedial alternatives for contaminated soils.

**Data Visualization Tool, Onondaga County Department of Water Environment Protection**

Mr. Ku developed a custom application using IDL to visualize a number of water quality data in two-dimensional (time versus depth) contour images collected by a real-time monitoring buoy in the Onondaga Lake. This application also graphically displays fish space metrics for the lake's habitat suitability for various fish species.

**Water Quality Model of the Seneca, Oneida, and Oswego Rivers, Onondaga County Department of Water Environment Protection**

Mr. Ku developed two- and three-dimensional data visualization tools with a graphical user interface (GUI) to assist model calibration using IDL.

**Performance Evaluation of Air Quality Monitoring Stations, Environmental Protection Administration, Taiwan**

Mr. Ku assisted in the development of quality assurance procedures for air quality data collected from 66 newly installed air quality monitoring stations using Fortran 77.

### PROFESSIONAL ACTIVITIES

#### Presentations

The Importance of Sorption Kinetics for Modeling Fate and Transport of Contaminated Sediments: Application to the Upper Hudson River PCB Site. Israelsson, P., P. Oates, J. Connolly, C. Forrest, W. Ku, P. Mugunthan, U. Kipka, J. Benaman, R. Petroni, L. Zheng, F. Chen, and K. Ziegler. Society of Environmental Toxicology and Chemistry North America 32nd Annual Meeting, November 17, 2011.

Factors Driving Resuspension during Hudson River Phase 1 Dredging. Connolly, J., W. Ku, and S. Hood. Sixth International Conference on Remediation of Contaminated Sediments, New Orleans, Louisiana, February 10, 2011.

Initial Insights about Remedy Effectiveness Gained from Hudson River Phase 1 Dredging. J. Connolly, J. Benaman and W. Ku. Sixth International Conference on Remediation of Contaminated Sediments, New Orleans, Louisiana, February 10, 2011

Resuspension of PCBs during Phase 1 Dredging on the Upper Hudson River. W. Ku and J. Connolly. 26th Annual Meeting of the Society of Environmental Toxicology and Chemistry Hudson-Delaware Chapter, April 22, 2010.

Modeling for Remedial Decisions: Case Study of a Useful Model. Russell, K.T., J.R. Rhea, D. Glaser, W. Ku, and R.P. Cepko. Presented at the Fifth International Conference on Remediation of Contaminated Sediments, Jacksonville, Florida, February 2009.

Phosphorus Loading Reductions and Initial Recovery of Onondaga Lake, NY. Rhea, J.R., L. Moran, K.T. Russell, D. Glaser, W. Ku, and J.J. Mastriano. Proceedings of the Water Environment Federation 80th Annual Technical Exposition and Conference, San Diego, California, November 2007.

Use of Mathematical Models to Evaluate Management Options for Reducing PCB Bioaccumulation by Fish in Two Streams at the Neal's Landfill Site, Bloomington, Indiana. Russell, K.T., J.R. Rhea, W. Ku, D. Glaser, and R.P. Cepko. Proceedings of the Water Environment Federation 79th Annual Technical Exposition and Conference, Dallas, Texas, November 2006.

Experimental Study of Sedimentation Characteristics for Jet Discharge into Shallow Basins. Atkinson, I., J.F., M.I. Bursik, and W. Ku. 9th International Symposium on the Interactions Between Sediments and Water, Banff, Canada, 2002.

### Publications

Model of Zebra Mussel Growth and Water Quality Impacts in the Seneca River, NY. Glaser, D., J.R. Rhea, D. Opdyke, K.T. Russell, K. Ziegler, W. Ku, L. Zheng, and J.J. Mastriano. Lake and Reservoir Management 25(1): 49-72, 2009.

# RICARDO N. PETRONI

**Senior Managing Engineer**

## PROFESSIONAL HISTORY

Anchor QEA, Senior Managing Engineer, 2007 to present
Specialized Environmental Modeling, President, 2012 to present
Fundación Climagro, President and founder, 2003 to 2007
EIH S.A., Director, 2003 to 2007
Instituto Tecnológico Buenos Aires, Argentina, Professor, 2003 to 2005
EIH S.A., Project Manager, 1998 to 2003
EIH S.A., Junior Engineer, 1994 to 1997
Universidad Nacional de La Plata, La Plata, Argentina, Graduate Assistant, 1994 to 1997

## EDUCATION

Universidad Austral, Pilar, Argentina, M.B.A., 2005
Massachusetts Institute of Technology, M. Eng., Environmental Engineering, 1998
Universidad Nacional de La Plata, La Plata, Argentina, Hydraulic and Civil Engineer, 1994

## EXPERIENCE SUMMARY

Mr. Petroni's main expertise is in the area of mathematical modeling of hydrodynamic, water quality, and sediment transport processes. He has worked on numerous projects in South America and the United States. As part of a large South American project, he developed a contaminant fate and sediment transport model that was used in several multi-million dollar studies of the Rio de La Plata (Argentina). Associated with that modeling, Mr. Petroni was also involved in the development and deployment of real-time monitoring networks. The hydrologic real-time monitoring system at the Itaipu Dam (Brazil) is one of the examples of his work in this area. In addition to his technical knowledge, Mr. Petroni has developed management skills that led him to become the director of a consulting firm in Argentina and the founder of Fundacion Climagro, a non-governmental organization devoted to the gathering and analysis of climatical information for agro-business in Argentina.

## REPRESENTATIVE PROJECT EXPERIENCE

### *Modeling and Field Studies*

#### Upper Hudson River Dredging, General Electric Company

Mr. Petroni participated in the polychlorinated biphenyl (PCB) dredging process of the Upper Hudson River close to Fort Edward, New York. He managed the hydrodynamic and sediment transport modeling to evaluate the potential impacts of the dredging process in the study area.

#### Lower Passaic River, Small Parties Group

Mr. Petroni participated regularly in the technical committee that guides the Remedial Investigation and Feasibility Study (RI/FS) for potentially responsible parties on the Lower Passaic River. He acted as chairman of the modeling subcommittee.

**Sediment Transport Model for the Lower Willamette River, Lower Willamette Group**

Mr. Petroni participated in a large-scale RI/FS project of the Lower Willamette River, which is a large tributary to the Columbia River close to Portland, Oregon. He managed the development and implementation of a two-dimensional (2-D) sediment transport model that is currently used to investigate contaminated sediment resuspension and provides input to a fate model.

**Sediment Transport Model for Mitchell Bay, ExxonMobil, Inc.**

Mr. Petroni participated in a sediment transport study for the Mitchell Bay area located adjacent to the Houston Ship Channel in Baytown, Texas. He managed the development and implementation of a 2-D hydrodynamic and sediment transport model that will be used to investigate alternatives to reduce dredging in the dock areas. This model includes a novel methodology to account for the resuspension caused by vessel propellers (prop-wash).

**Sediment Transport Model for the Engineering Evaluation/Cost Analysis at the Gasco Sediments Site, NW Natural**

Mr. Petroni participated in the Engineering Evaluation/Cost Analysis for the Gasco Sediments Site located in the Lower Willamette River close to Portland, Oregon. He managed the development and implementation of a 2-D sediment transport model that was used to investigate contaminated sediment resuspension and provide input to a fate model.

**Upper Hudson River Floodplain Assessment, General Electric Company**

Mr. Petroni participated in the assessment of the floodplain contamination of the Upper Hudson River in New York from Fort Edwards to Troy. He managed the development of a hydrodynamic model that includes the floodplain and was used to calculate the inundation contours for flood events of different return period. The results of this model were used to inform the field study to characterize PCB concentrations in the floodplain.

**Navigation Channel Design for the Rio Uruguay, Comisión Administradora del Rio Uruguay, Argentina/Uruguay**

Mr. Petroni participated in the design of an approximately 150 kilometer (km)-long navigation channel designed to provide large cargo vessels access to the Rio Uruguay ports in Argentina and Uruguay. He managed the development of a one-dimensional general model and several 2-D hydrodynamic and sediment transport local models to analyze the impact on sedimentation and water elevation levels of the proposed project. The model was also used to analyze environmental impact during dredging.

**Tittabawassee River, The Dow Chemical Company**

Mr. Petroni participated in a large-scale remediation project in the Tittabawassee River at Midland, Michigan. He managed the development of a sediment transport model and preliminary chemical fate model to analyze current conditions and evaluate potential remedial alternatives. He co-developed a new sediment bedload algorithm able to simulate long-term transport processes in non-cohesive sediments. This new algorithm provided the necessary information to drive a contaminant fate model.

**San Jacinto River, MIMC and IP**

Mr. Petroni participated in the dioxin remediation project of waste impoundments located in the San Jacinto River close to Houston, Texas. He managed the development of hydrodynamic and sediment transport models to aid the time critical remedial action design and evaluated potential remedial alternatives as part of the RI/FS study.

**Victoria Harbor Sediment Management Project, Government of Canada**

Mr. Petroni participated in a project to investigate sources of contaminated sediments on Victoria Harbor in British Columbia, Canada. Mr. Petroni supervised the implementation of a three-dimensional (3-D) hydrodynamic and sediment transport model of the harbor that was used to analyze the ongoing and legacy contaminant sources and provided insight for future remediation work.

**Esquimalt Graving Dock Remediation, Government of Canada**

Mr. Petroni participated in a project to analyze the stability of sediments located below the Esquimalt Graving Dock in British Columbia, Canada. He conducted detailed modeling of current velocity generated by vessel propellers (a.k.a. prop-wash) using a Computational Fluid Dynamics model. The velocity profiles were used to calculate the stability of sediments located below the dock and investigate different alternatives to mitigate erosion.

**Mayport Naval Base, Applied Science Associates**

Mr. Petroni participated in the analysis of the impact of additional dredging in the Mayport Naval Base in Jacksonville, Florida. He managed the development of a 3-D hydrodynamic and sediment transport model that was used to calculate the quantity and distribution of sedimentation in the port basin. The model was also used to analyze the impact of deepening of the port entrance and portions of the basin.

**Sediment Stability Analysis for the Lower Duwamish Waterway, Lower Duwamish Waterway Group**

Mr. Petroni participated in a large-scale project to investigate the stability of contaminated sediment in the Lower Duwamish Waterway, which is a salt-wedge estuary located near Seattle, Washington. He combined hydrodynamic and sediment transport modeling analyses to evaluate stability of contaminated sediment in the study area, as well as the rate of natural recovery over multi-year periods.

**Sediment Stability Analysis for Patrick Bayou, Patrick Bayou Joint Defense Group**

Mr. Petroni participated in a project to investigate stability of contaminated sediment in Patrick Bayou, which is part of the Galveston Bay and Houston Navigation Channel complex in Texas.

He combined hydrodynamic and sediment transport modeling analyses to evaluate stability of contaminated sediment in the study area.

**Characterization of Water Quality of the Rio de La Plata, Aguas Argentinas S.A. (Suez Group)**
Mr. Petroni participated in the planning and processing of field work for characterizing water quality of the Rio de La Plata. This project included measurements of more than 40 discharge locations and simultaneous sampling of more than 100 point sources inside the Rio de La Plata.

**Development of the Integral Sanitation Plan, Aguas Argentinas S.A. (Suez Group)**
Mr. Petroni managed the hydrodynamic and pollution transport modeling to optimize the location of the outfalls in the Rio de La Plata. The Integral Sanitation Plan is a master plan for wastewater handling and treatment for Buenos Aires and its suburbs in Argentina. It serves about 10 million people and comprises designs for pipelines, combined sewer overflow conversions, pumping plants, treatment plants, and multiple outfalls into the Rio de La Plata.

**Hidrovia Parana-Paraguay, Comité internacional de la Hidrovia**
Mr. Petroni participated in the field study and managed the 2-D hydrodynamic and sediment transport modeling of reaches of the Parana River that presented navigation problems. The total extent of the navigation channel in this river is 3,000 km, with approximately 30 km considered critical enough to necessitate being analyzed using modeling tools.

**Buenos Aires – Colonia Bridge, CARP, Comisión Administradora del Rio de La Plata**
Mr. Petroni managed a hydrodynamic and sediment transport modeling study to analyze the impact of bridge construction on sedimentation in the navigation channels. The bridge project is 40 km long and has a potential impact on about 100 km of commercial navigation channels.

**Rosario City Water Intake, Aguas Provinciales de Santa Fe S.A. (Suez Group)**
Mr. Petroni performed the field study and managed the hydrodynamic and pollution transport model of the Parana River near Rosario, Argentina, which has a population of about 1.5 million, to determine the impact of potential oil spills on the water intake for the city.

**PRAME Project, Aguas Argentinas South America (Suez Group)**
Mr. Petroni designed and managed the construction of a real-time monitoring network and modeling framework to prevent polluted water from raw wastewater outfalls entering the water intake for Buenos Aires in Argentina. The real-time network consisted of automated level measurements collected every hour via cellular phone, and it used as a boundary condition for a previously calibrated hydrodynamic and contaminant transport model. This model was run every 8 hours, and results were provided to the plant operators.

## RICARDO N. PETRONI

**Senior Managing Engineer**

### Solid Waste Management Plan for Lanus and Lomas de Zamora, Comité Matanza - Riachuelo

Mr. Petroni supervised the field work and developed the conceptual model for groundwater and surface pollution transport generated by informal solid waste disposals.

### Sedimentation Study in the Punta Indio/Emilio Mitre Navigation Channel, Hidrovia South America

Mr. Petroni managed the hydrodynamic and sediment transport modeling effort to determine changes in sedimentation rates caused by the deepening of the commercial navigation channel in the Rio de La Plata, which connects the Port of Buenos Aires and the Parana River to the Atlantic Ocean.

### Sedimentation Study for the Martin Garcia Navigation Channel, Comision Administradora del Rio de La Plata

Mr. Petroni participated in the field work and in the modeling effort related to the design, bid document generation, contracting, and construction inspection of an alternative navigation channel that connects the Parana River to the Atlantic Ocean through the Rio de La Plata.

*Monitoring Networks*

### Itaipu Dam Hydrologic Telemetry System, Ente binacional Itaipu (Brazil/Paraguay).

Mr. Petroni managed the procurement of a turn-key system for the Itaipu Dam (Brazil/Paraguay). The provision included the functional design of the field equipment and central station software, manufacture of the equipment, installation at 42 locations in the rainforest, and personnel training for operation of the system. The system collects hydrologic and meteorologic data that is transmitted every 3 hours using bi-directional satellite communications.

### Resistencia Flood Alert System, Government of Chaco Province

Mr. Petroni supervised the design and implementation of a turn-key flood alert system for the city of Resistencia, Chaco Province, Argentina. This system has 30 hydrologic stations connected to a central station using ultra-high frequency radio.

### UTE Hydrologic Telemetry System, UTE Uruguay (National Power Generation Agency of Uruguay)

Mr. Petroni supervised the technology selection for the turn-key system provided to UTE. This system controls hydrologic variables at about 30 stations and provides UTE with information for the operation of their hydroelectric power plants. The system communicates in real-time using cell phones.